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Shioda

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[54] **METHOD OF MANUFACTURING WIRE HARNESS FOR AUTOMOBILE USE**

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[30] Foreign Application Priority Data

Feb. 26, 1997 [JP] Japan 9-042430

[51] **Int. Cl.**[6] **H01R 43/04**

[52] **U.S. Cl.** ..... **29/861**; 29/861; 29/857; 29/753; 29/763; 29/33 M

[58] **Field of Search** ..... 29/861, 857, 749, 29/748, 753, 755, 762, 763, 33 M; 140/92.1

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Primary Examiner—Lee Young
Assistant Examiner—Minh Trinh
Attorney, Agent, or Firm—Oliff & Berridge, PLC

[57] **ABSTRACT**

A method of effectively manufacturing various types of wire harnesses of complicated wiring structure in which a predetermined number of connectors necessary for a unit wire harness are arranged on a movable pallet. The pallet is then moved so that crimp-style terminal of one of the connectors can come to a crimp connecting position of a rotatable crimp connecting press. An end of an electric wire is fed to the crimp-style terminal at the crimp connecting position. The end of the electric wire is then connected to the terminal by the rotatable crimp connecting press. Then, the pallet is moved again, and the other end of the electric wire is connected to a crimp-style terminal of a predetermined connector by crimp connection. The series of motions are repeated until all terminals necessary for the unit wire harness are connected to the electric wires by crimp connection. According to this method, a rotatable crimp connecting press has a plurality of different crimp connecting blades.

8 Claims, 7 Drawing Sheets

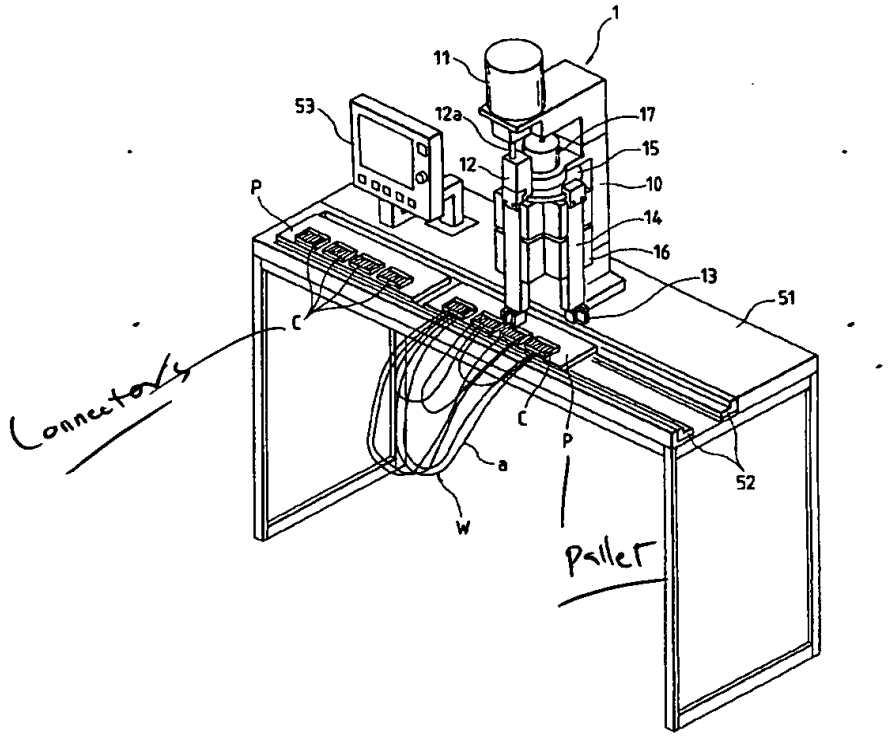


FIG. 1

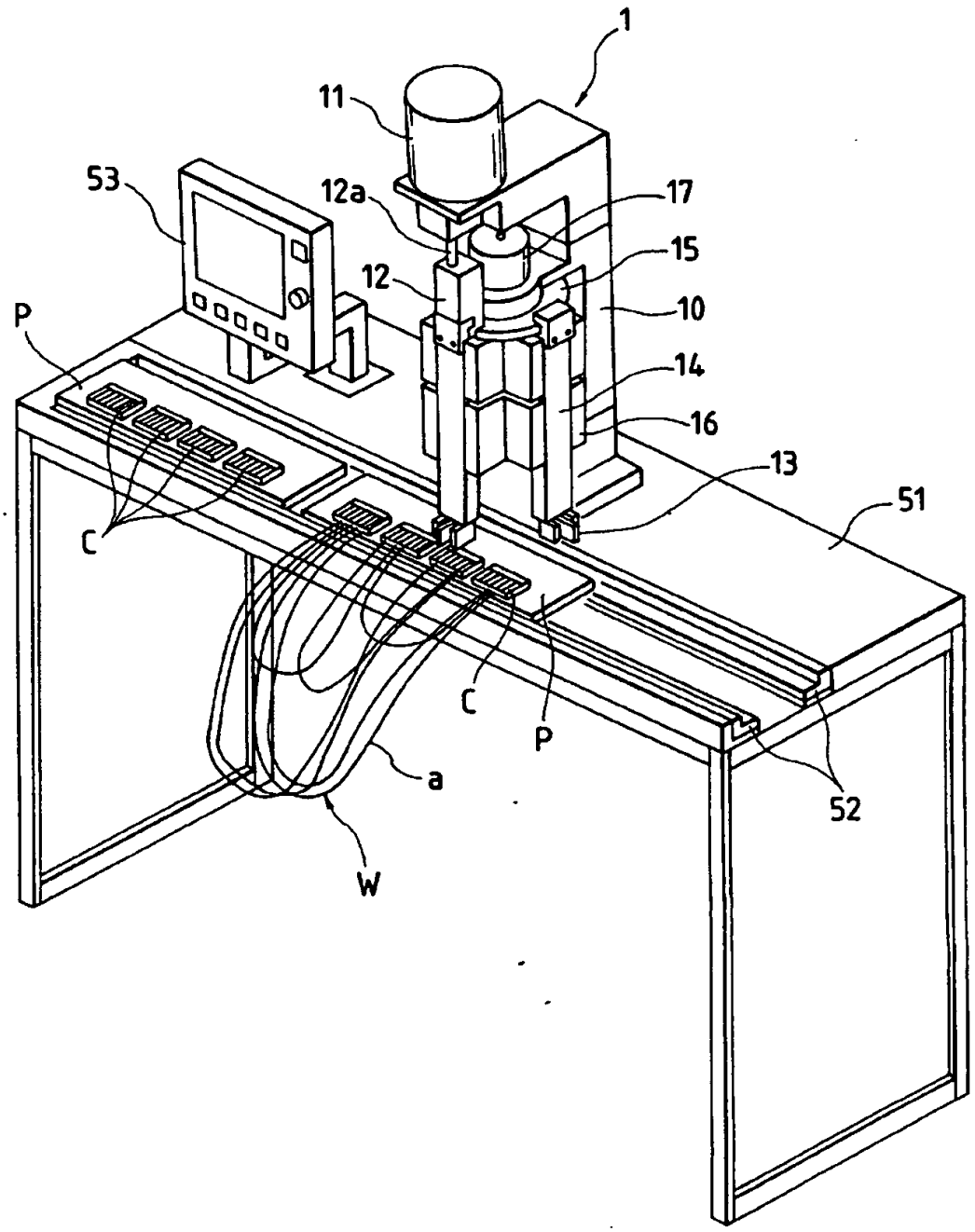


FIG. 2

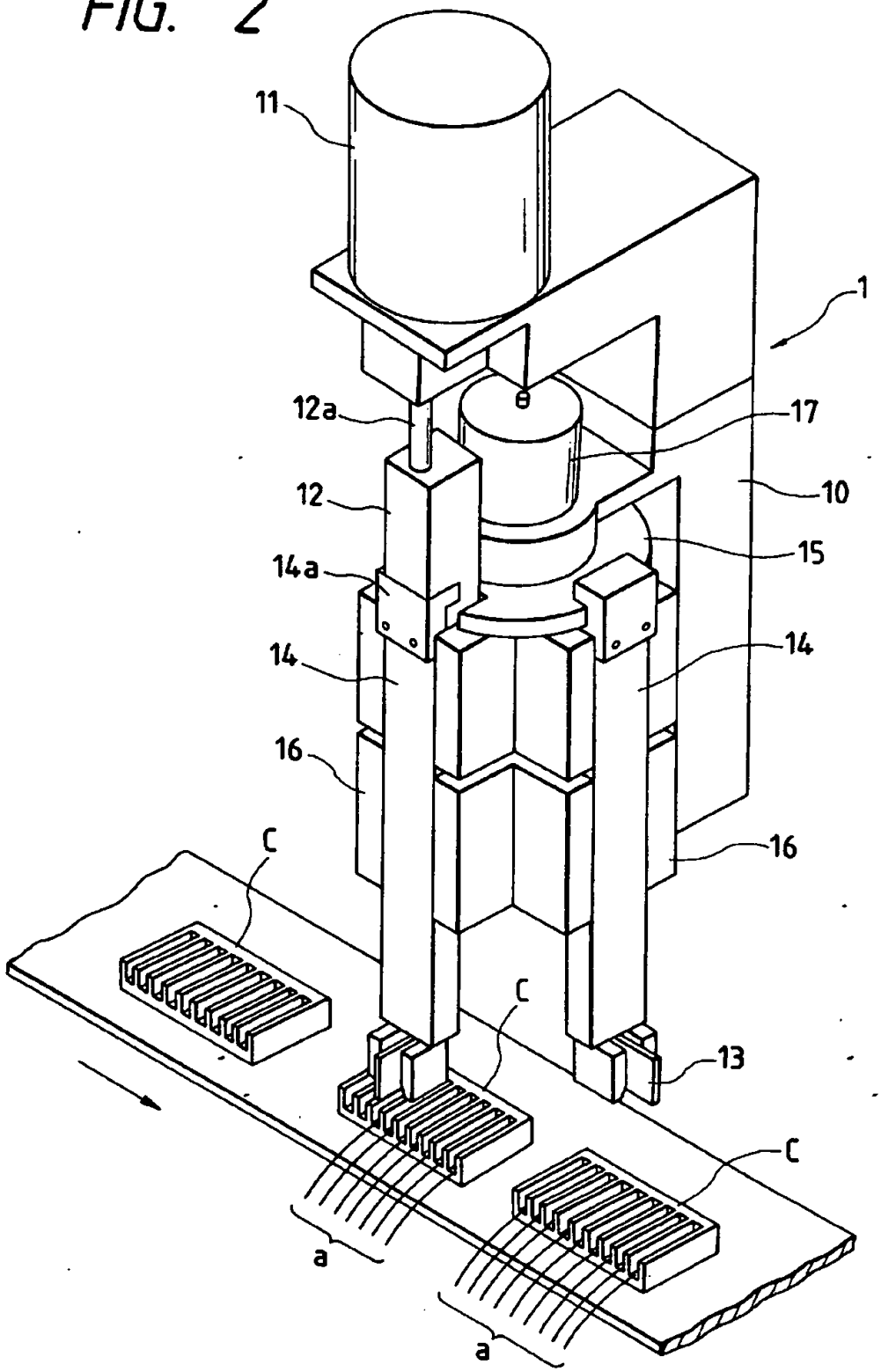


FIG. 3

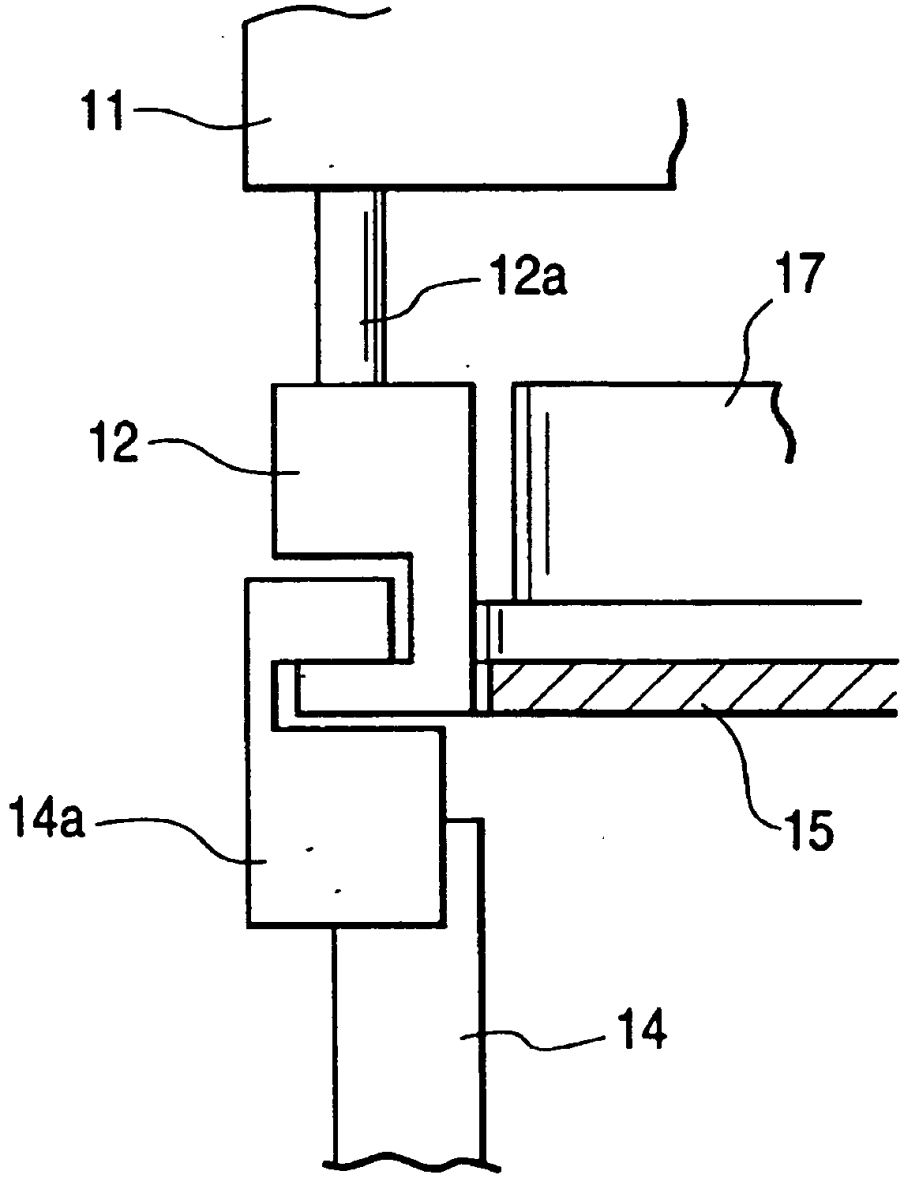


FIG. 4(a)

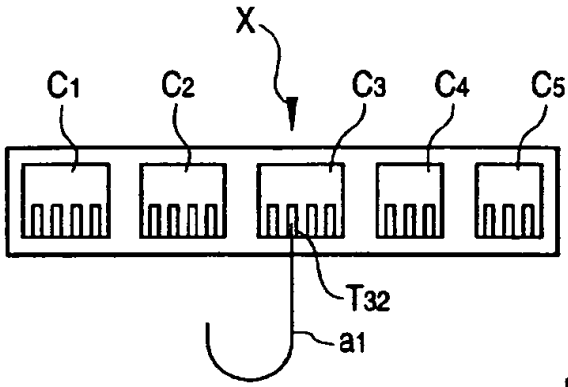


FIG. 4(b)

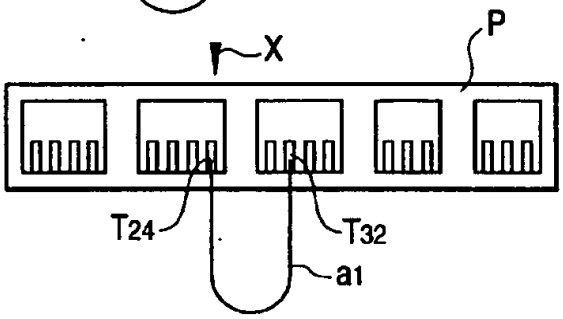


FIG. 4(c)

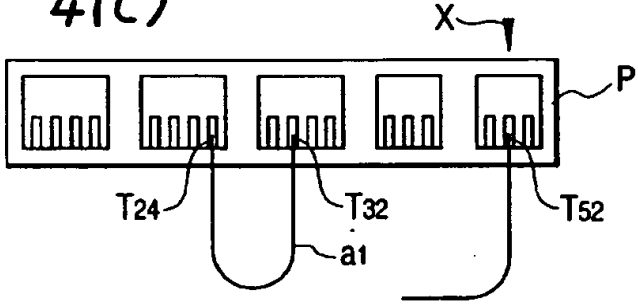


FIG. 4(d)

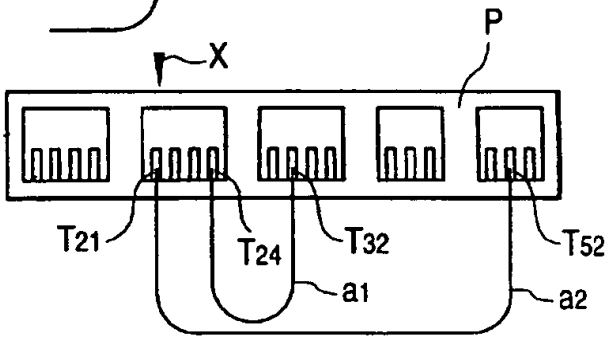


FIG. 5(a)

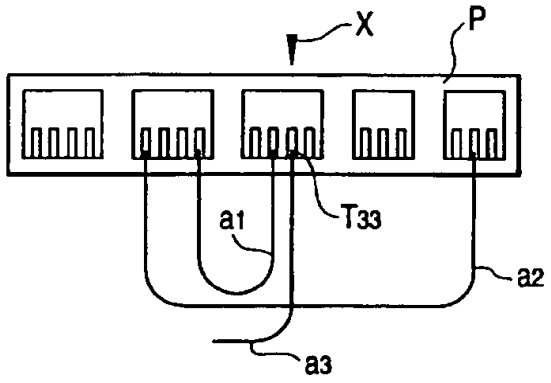


FIG. 5(b)

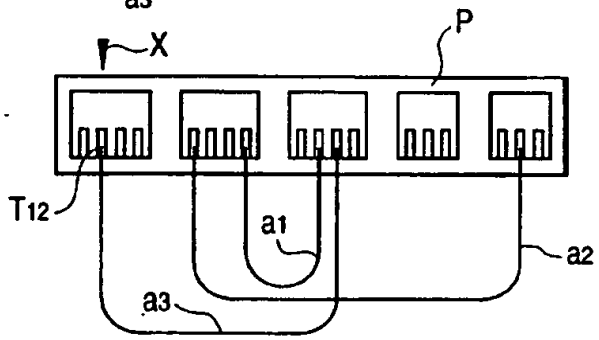


FIG. 5(c)

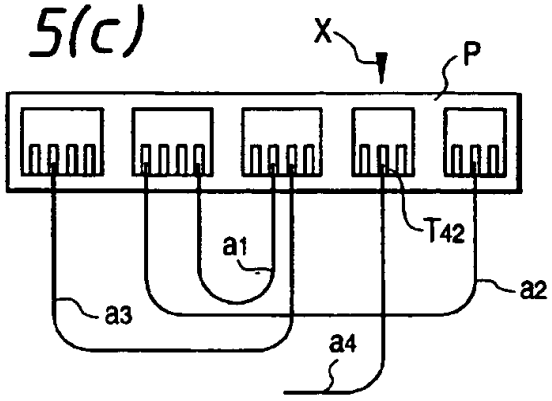
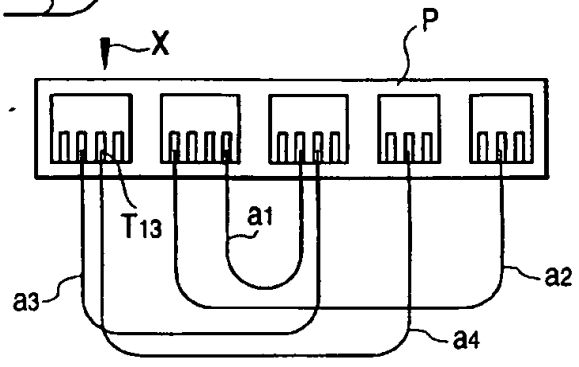


FIG. 5(d)



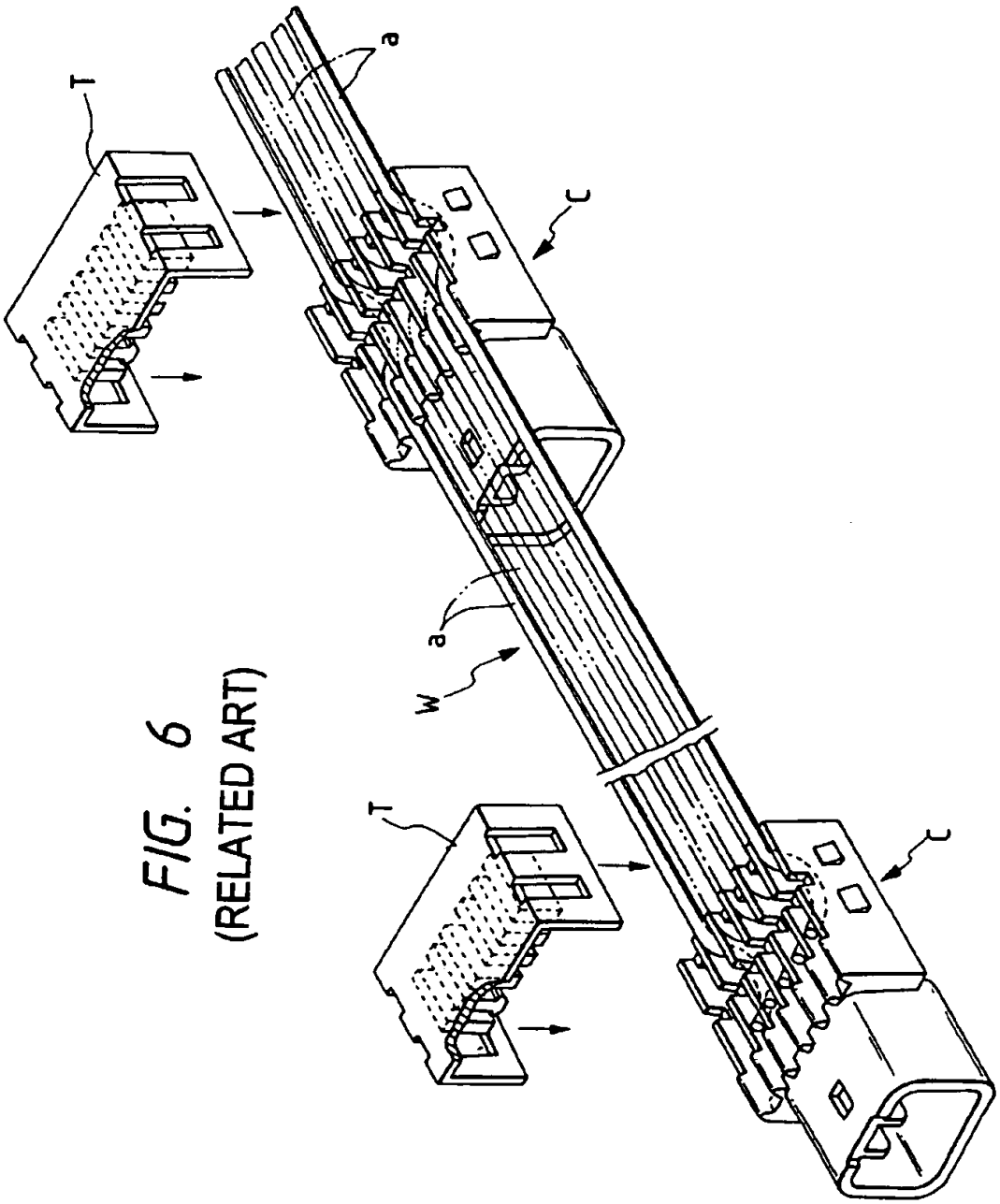


FIG. 6
(RELATED ART)

FIG. 7
(RELATED ART)

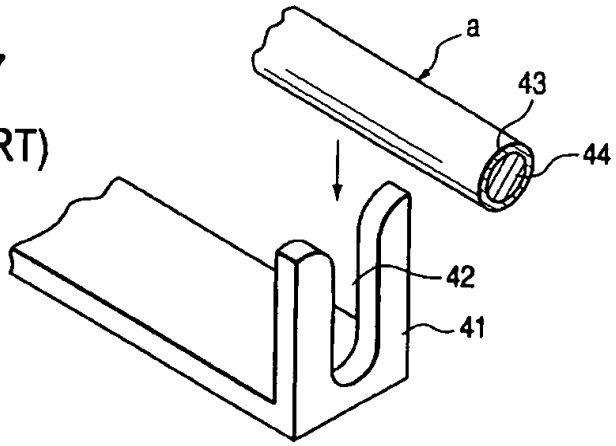
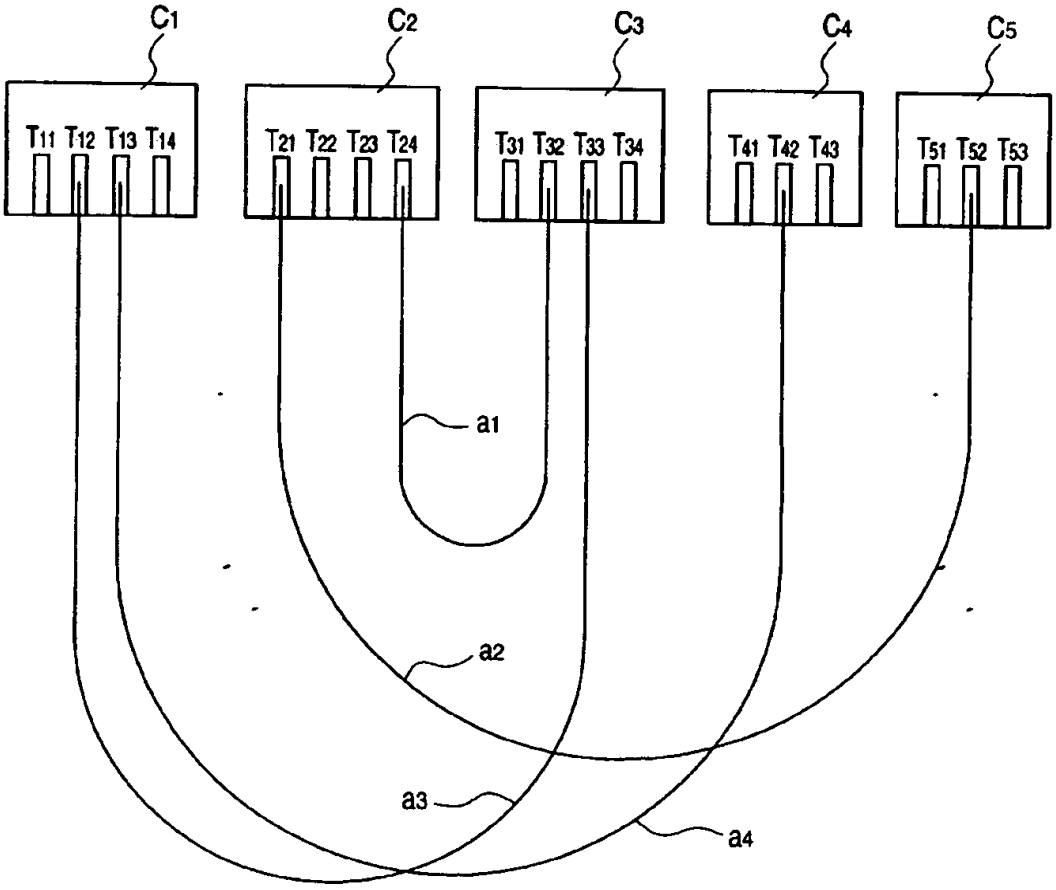


FIG. 8



METHOD OF MANUFACTURING WIRE HARNESS FOR AUTOMOBILE USE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method of manufacturing a wire harness for automobile use.

2. Discussion of Related Art

An example of the wire harness for automobile use is shown in FIG. **6**, which is composed in such a manner that electric wires "a" are arranged in parallel with each other, connectors C are connected to appropriate portions of the electric wires in the longitudinal and the transverse direction, and the connectors C are covered with covers T if necessary.

From the viewpoint of enhancing the working efficiency, the electric wires "a" are frequently connected to the connectors C by means of crimp-style connection, also referred to herein as a crimp connection. As shown in FIG. **7**, this crimp-style connection is conducted in the following manner. In the connector, there is provided a crimp-style terminal **41** having a groove **42**, the width of which is somewhat smaller than the outer diameter of the electric wire "a". The electric wire "a" is fed into the groove **42** and pushed down by a crimp connecting blade not shown in the drawing, so that the electric wire "a" can be press-fitted into the groove **42**. In the case of an electric wire "a" composed of a bundle of conductors **44** and covering material **43** which covers the bundle of conductors **44**, the covering material **43** is torn by the wall of the groove **42** when the electric wire "a" is press-fitted into the groove, so that the bundle of conductors **44**, which have been exposed, come into contact with the terminal **41** and electrically communicate with the terminal **41**. At the same time, the electric wire "a" is fixed into the groove **42** by the action of spring-back of the terminal **41**.

In this connection, an intensity of the spring-back action of the terminal **41** and a pushing distance of the electric wire "a" which has been pushed down are relatively related to each other. When the pushing distance of the electric wire "a" is increased, the intensity of the spring-back action of the terminal **41** is increased. However, when the pushing distance of the electric wire "a" is excessively increased, the terminal **41** is plastically deformed, and the intensity of the spring-back action is decreased or further decreased to zero. In the above case, the crimp connection becomes unstable, and the electric wire "a" is disconnected from the terminal **41** even if a low intensity of force is given to the crimp connecting section from the outside or even if the crimp connecting sectiog is somewhat oscillated.

In the same manner, when the pushing distance of the electric wire "a" is too small, the intensity of the spring-back action becomes too low. Also, the crimp connection becomes unstable in this case.

In order to connect the electric wire "a" to the groove **42** with pressure in a stable state by the action of spring-back so that the electric wire "a" can be positively communicated with the terminal **41**, it is necessary that the electric wire "a" is pushed into the groove **42** by an appropriate distance. When this crimp connection, in which the electric wire "a" is pushed into the groove **42** by an appropriate distance, is manually conducted by a worker, the pushing distance of the crimp connecting blade fluctuates, that is, when a different worker conducts the crimp connection by pushing the electric wire "a" into the groove **42**, the pushing distance fluctuates.

Usually, a plurality of electric wires "a" are connected to one connector C as shown in FIG. **6**. When the plurality of electric wires "a" are manually connected by a worker one by one, the pushing distance of the electric wire "a" for each terminal fluctuates even if the same worker conducts this connection.

When the number of electric circuits (the number of electric wires "a") increases, the number of crimp connections also increases. In accordance with the increase in the number of crimp connections, there is a possibility of the occurrence of erroneous wiring. In order to solve the above problems, this crimp connection has been automatized recently.

When an automatic crimp connecting machine is used in the manufacture of the wire harness, the aforementioned fluctuation of connection can be avoided and further the connecting speed can be increased. However, the following problems may be encountered. FIG. **8** shows an example of connections made by connectors and terminals, which are arranged as follows. The connector includes five connectors C_1, C_2, C_3, C_4 and C_5. Connector C_1, has four terminals of T_{11} to T_{14}, connector C_2 has four terminals of T_{21} to T_{24}, and connector C_3 has four terminals of T_{31} to T_{34}. Connector C_4 has three terminals of T_{41} to T_{43}, and connector C_5 has three terminals of T_{51} to T_{53}. Electric wire "a" includes four electric wires of a_1, a_2, a_3 and a_4, which are complicatedly connected to the connectors as shown in the drawing. In order to manufacture the above wire harness, the structure of the manufacturing apparatus becomes complicated and the size of the apparatus is increased. As a result, the manufacturing cost is raised. Therefore, it is impossible to apply the automatic connecting machine to a case in which a large number of types of products are produced, wherein a quantity of each type of product is small.

In an automobile factory in which the number of electronic parts to be incorporated into automobiles is increased day after day, it is an urgent necessity to manufacture various types of wire harness of complicated wiring effectively.

SUMMARY OF THE INVENTION

It is an object of the present invention to effectively manufacture various types of wire harness, the wiring structure of which is complicated.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an overall perspective view showing an embodiment of the present invention.

FIG. **2** is a perspective view of the crimp connecting press shown in FIG. **1**.

FIG. **3** is a cutaway front view of the primary portion of FIG. **2**.

FIGS. **4A–4D** are plan views showing a model of the process of manufacturing the wire harness of the embodiment.

FIGS. **5A–5D** are plan views showing a model of the successive process of FIG. **4**.

FIG. **6** is a perspective view showing an example of the wire harness.

FIG. **7** is a perspective view showing a state of crimp connection.

FIG. **8** is a plan view showing an exemplary model of the wire harness of complicated wiring structure.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In order to solve the above problems, the present invention is to provide a method of manufacturing a wire harness

for automobile use comprising the steps of: arranging a predetermined number of connectors necessary for a unit wire harness on a movable pallet; moving the pallet so that a crimp-style terminal (also referred to herein as a crimp terminal) of one of the connectors can come to a crimp connecting position of a crimp connecting press; feeding an end of an electric wire to the crimp-style-terminal that has come to the crimp connecting position; crimping one end of the electric wire by the crimp connecting press; moving the pallet again; crimping the other end of the electric wire so as to be connected to a crimp-style terminal of a predetermined connector; and repeating a series of motions until all connectors necessary for the unit wire harness are connected to the electric wires by means of crimp connection.

According to the above method, it is possible to conduct the crimp connection of wire harness with a crimp connecting press, the motion of which is simple, and it is also possible to reduce the size of the entire apparatus and the manufacturing cost can be reduced. Accordingly, it is possible to manufacture various types of wire harness of complicated wiring structure.

At this time, the movement of the pallet can be numerically controlled. Due to the foregoing, the terminal can be quickly positioned at a crimp connecting position with high accuracy.

The movement of a crimp connecting blade of the crimp connecting press can also be numerically controlled. Due to the foregoing, the crimp connecting blade can be quickly positioned at a position of the most appropriate distance with high accuracy.

The crimp connecting press has a function of automatically replacing the crimp connecting blade. Due to the foregoing, much labor is not required for replacing the crimp connecting blade, and further the replacing work can be executed quickly.

Referring to FIGS. **1** to **5**, an embodiment of the present invention will be explained below. In the wire harness manufacturing method of this embodiment, the apparatus shown in FIG. 1 is used. In the drawing, reference numeral **51** is a frame in which the electric wires "a" are connected to connectors by means of crimp connection. There are provided rails **52** on an upper surface of the frame **51** in the longitudinal direction, wherein these rails are arranged on the worker's side with respect to the width direction of the frame **51**. On the rails **52**, there are provided pallets P which slide on the rails **52**. One or more connectors C are put on each pallet P. Crimp connecting work is conducted on this pallet P.

There is provided a crimp connecting press **1** on an upper surface of the frame **51** at the center in the longitudinal direction, wherein this crimp connecting press **1** is arranged at the rear with respect to the width direction of the frame **51**. Also, there is provided a control panel **53** for operating the crimp connecting press **1** and the drive mechanism of the pallet P.

As shown in FIG. 2, there is provided a servo motor **11** on an upper surface of the housing **10** of this crimp connecting press **1**. This servo motor **11** holds a screw shaft **12***a* of the connecting rod **12** by means of a ball screw structure. Therefore, when the ball guide nut of the ball screw structure is turned, the screw shaft **12***a* (connecting rod **12**) can be elevated. As shown in FIG. 3, a lower end portion of this connecting rod **12** is formed into a hook-shape. This hook-shaped portion is engaged with an upper end hook portion **14***a* of the elevating rod **14** of the crimp connecting blade **13**. Due to the above arrangement, when the connecting rod **12** is elevated, the crimp connecting blade **13** can be also elevated.

As shown in FIG. **2**, there are four elevating rods **14** of the crimp connecting blades **13** around a disk **15** integrated with the housing **10**. The upper end hook portions **14***a* of the elevating rods **14** are engaged with a circumferential edge of the disk **15**, so that the elevating rods **14** can be slidably supported. In this case, the number of the crimp connecting blades may be arbitrarily determined. There are provided guides **16** on both sides of each elevating rod **14**. The elevating rod **14** is elevated between the guides **16**. Each guide **16** is fixed to a rotary cylinder (not shown) rotatably arranged on a lower surface of the disk **15**. When this rotary cylinder is rotated by a rotary actuator **17** on the disk **15**, an arbitrary crimp connecting blade **13** is set at the crimp connecting position. At this time, the lower end hook portion of the connecting rod **12** fills a cutout portion of the disk **15** located at a crimp connecting position. Therefore, the elevating rod **14** can be moved without causing any problem. It is possible to use a pulse motor instead of the rotary actuator **17**.

In the same manner as that of the elevating rod **14** of the crimp connecting press **1**, the pallet P is moved when a screw shaft of a ball screw to which the pallet P is fixed is driven by a servo motor. This ball screw and servo motor are located under the pallet P and not illustrated in FIGS. **1** and **2** because they are hidden by the pallet P. However, the principle of the driving mechanism is the same as that of the elevating rod **14** of the crimp connecting press **1** described before. Accordingly, the detailed illustration and explanation are omitted here.

A method of manufacturing a wire harness of this embodiment, in which the above apparatus is used, will be explained as follows. The wire harness explained in the conventional example shown in FIG. **8** is taken up here as an example of the wire harness to be manufactured. As described before, there are provided five connectors C_1, C_2, C_3, C_4 and C_5, which will be referred to as connectors C hereinafter. Connector C_1 has four terminals of T_{11} to T_{14}, connector C_2 has four terminals of T_{21} to T_{24}, and connector C_3 has four terminals of T_{31} to T_{34}. In this case, the terminal numbers are put on the terminals from the left of the drawing. Connector C_4 has three terminals of T_{41} to T_{43}, and connector C_5 has three terminals of T_{51} to T_{53}. Electric wire "a" includes four electric wires of a_1, a_2, a_3 and a_4. In this case, both ends of each electric wire "a" are connected to the crimp connecting terminal T by means of crimp connection. In FIGS. **4** and **5** which will be referred in the explanations of manufacturing process, in order to avoid the complication of the drawings, only the terminal numbers used in the explanations are shown in the drawings.

First, the aforementioned five connectors C are put on the pallets P being aligned in a line. Of course, this work to put the connectors C on the pallets P can be automatized. However, for the purpose of reducing the overall size of the apparatus, this work is manually executed by a worker in this embodiment.

Next, the pallet P is moved by the servo motor via the ball screw, and the second crimp connecting terminal T_{32} of the connector C_3 is made to come to a crimp connecting position X which is immediately below the crimp connecting blade **13** of the crimp connecting press **1**. At this time, an amount of rotation of the servo motor to drive the pallet P is digitally controlled so that the movement of the pallet P can be optimized.

Then, as shown in FIG. **4**(*a*), one end of the electric wire a_1 is manually fed to a groove of the crimp connecting terminal T_{32} that has come to the crimp connecting position

X. Of course, this electric wire a_1 can be automatized. However, for the same reason as that of the work in which the connector C is put on the pallet P, this work is manually executed in this embodiment for preventing the size of the apparatus from increasing.

Next, one end of the electric wire a_1 is connected to the connector C by means of crimp connection by the crimp connecting press **1**. At this time, the servo motor **11** is operated, so that the crimp connecting blade **13** is lowered, and the electric wire a_1 in the groove of the crimp connecting terminal T_{32} is pushed down, so that the electric wire a_1 can be connected to the connector with pressure. In this case, in the same manner as that of the movement of the pallet P, an amount of rotation of the servo motor **11** of the crimp connecting press **1** is digitally controlled, so that a pushing distance of the electric wire a_1 can be optimized. In this case, torque and rotating speed are also controlled, so that the pushing force and the pushing speed can be optimized. In this connection, in order to prevent the complication of drawings, reference numerals C_1, C_2, C_3, C_4 and C_5 of the connector are omitted in FIGS. **4**(*b*) to **4**(*d*) and FIGS. **5**(*a*) to **5**(*d*) described later. In the drawings, the connectors C_1, C_2, C_3, C_4 and C_5 are aligned from the left of the pallet P.

After the crimp connection of one end of the electric wire a_1 has been completed, the pallet P is moved again. As shown in FIG. **4**(*b*), the crimp connecting terminal T_{24} of the connector C_2 to which the other end of the electric wire a_1 is connected by means of crimp connection is moved to the crimp connecting position X, and the other end of the electric wire a_1 is manually fed to this position by a worker, and this portion is subjected to crimp connection by the press **1**.

Next, in order to connect the electric wire a_2 with pressure by means of crimp connection, the pallet P is moved so that the crimp connecting terminal T_{52} of the connector C_5, to which the electric wire a_2 is connected by means of crimp connection, can come to the crimp connecting position X. As shown in FIG. **4**(*c*), when the crimp connecting terminal T_{52} has come to the crimp connecting position X, one end of the electric wire a_2 is fed into the groove of the crimp connecting terminal T_{52}, and the crimp connecting terminal is connected by means of crimp connection by the crimp connecting press **1**.

Next, the pallet P is moved so that the crimp connecting terminal T_{21} of the connector C_2, to which the other end of the electric wire a_2 is connected by means of crimp connection, can come to the crimp connecting position X. As shown in FIG. **4**(*d*), when the crimp connecting terminal T_{21} has come to the crimp connecting position X, the other end of the electric wire a_2 is fed into the groove of the crimp connecting terminal T_{21}, and the crimp connecting terminal is connected by the press **1** by means of crimp connection.

Next, in order to connect the electric wire a_3 by means of crimp connection, the pallet P is moved so that the crimp connecting terminal T_{12} of the connector C_1, to which the electric wire a_3 is connected by means of crimp connection, can come to the crimp connecting position X. As shown in FIG. **5**(*a*), when the crimp connecting terminal T_{12} has come to the crimp connecting position X, one end of the electric wire a_3 is fed into the groove of the crimp connecting terminal T_{12}, and the crimp connecting terminal is connected with pressure by the press **1** by means of crimp connection.

Next, as shown in FIG. **5**(*d*), the pallet P is moved so that the crimp connecting terminal T_{33} of the connector C_3, to which the other end of the electric wire a_3 is connected by means of crimp connection, can come to the crimp connecting position X. When the crimp connecting terminal T_{33} has come to the crimp connecting position X, the other end of the electric wire a_3 is fed into the groove of the crimp connecting terminal T_{33}, and the crimp connecting terminal is connected by the press **1** by means of crimp connection.

Finally, in the same manner as that described before, the movement of the pallet P, the feed of the electric wire a_4 and the crimp connection by the crimp connecting press **1** are repeated, so that both ends of the electric wire a_4 are respectively connected by means of crimp connection to the terminal T_{13} of the connector C_1 and the terminal T_{42} of the connector C_4. In this way, wiring (crimp connection) of all electric wires "a" for the connectors C is completed, and the predetermined wire harness W can be provided.

In the case where it becomes necessary to replace the crimp connecting blade **13** because the size (outer diameter) of the electric wire "a" is different and accordingly the size (width and depth) of the groove of the crimp connecting terminal T is different, the rotary actuator **17** is driven, and a predetermined crimp connecting blade **13**, which has been previously prepared, is set at the crimp connecting position X, so that the crimp connecting work can be continued. The unit of this electric wire "a" is not limited to one piece of electric wire, but the unit of this electric wire "a" may be a flat cable in which a plurality of element wires are arranged in parallel with each other and formed into a plane using a tape. When the above flat cable is used, crimp connection is conducted on the plurality of grooves of the flat cable all at once.

As explained above, the present invention can provide the following effects. When a wire harness of complicated wiring structure is manufactured, the size of the manufacturing apparatus can be reduced, and it is possible to produce various types of products, the quantity of which is small, at low cost.

What is claimed is:

1. A method of manufacturing a unit wire harness for an automobile comprising the steps of:

arranging a predetermined number of connectors necessary for the unit wire harness on a movable pallet;

moving the pallet so that a first crimp terminal of one of the connectors comes to a crimp connecting position of a rotatable crimp connecting press;

locating a first end of an electric wire at the first crimp terminal that has come to the crimp connecting position;

crimping the first end of the electric wire by the rotatable crimp connecting press; subsequently moving the pallet again so that a second crimp terminal of a predetermined connector comes to the crimp connecting position of the rotatable crimp connecting press;

locating a second end of the electric wire at the second crimp terminal that has come to the crimp connecting position;

crimping the second end of the electric wire so as to be connected to the second crimp terminal; and

repeating the moving, locating and crimping steps as necessary until all connectors necessary for the unit wire harness are connected to the electric wires by crimp connections.

2. The method of manufacturing a unit wire harness for an automobile according to claim 1, wherein the movement of the pallet is numerically controlled.

3. The method of manufacturing a unit wire harness for an automobile according to claim 1, wherein the movement of

a crimp connecting blade of the rotatable crimp connecting press is numerically controlled.

4. The method of manufacturing a unit wire harness for an automobile according to claim 3, wherein the crimp connecting press has a function of automatically replacing the rotatable crimp connecting blade.

5. The method of manufacturing a unit wire harness for an automobile according to claim 1, wherein the moving of the pallet comprises moving the pallet along rails on a surface of a frame on which the rotatable crimp connecting press is arranged.

6. The method of manufacturing a unit wire harness for an automobile according to claim 1, wherein the rotatable crimp connecting press includes a plurality of crimp connecting blades accommodating different wire sizes and crimp terminal sizes, and wherein the method further comprises the rotatable crimp connecting press automatically selecting the crimp connecting blade suitable for the wire size and crimp terminal size.

7. The method of manufacturing a unit wire harness for an automobile according to claim 6, wherein the selecting comprises rotating the rotatable crimp connecting press to locate the selected crimp connecting blade at the crimp connecting position.

8. The method of manufacturing a unit wire harness for an automobile according to claim 4, wherein the automatic replacement of the crimp connecting blade comprises rotating the rotatable crimp connecting press to locate a different crimp connecting blade at the crimp connecting position.

* * * * *

United States Patent [19]

Funcik et al.

[11] **4,419,817**

[45] **Dec. 13, 1983**

[54] **ELECTRICAL HARNESS FABRICATION APPARATUS**

[75] Inventors: **Jack F. Funcik**, Downers Grove; **Clarence Kolanowski**, LaGrange, both of Ill.

[73] Assignee: **Molex Incorporated**, Lisle, Ill.

[21] Appl. No.: **310,479**

[22] Filed: **Oct. 13, 1981**

[51] **Int. Cl.**³ **B23P 19/00**

[52] **U.S. Cl.** **29/749**; 29/857

[58] **Field of Search** 29/564.4, 564.6, 564.8, 29/747, 753, 566.2, 566.3, 867, 857, 861

[56] **References Cited**

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4,126,935	11/1978	Rhines et al.	29/857
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4,373,261	2/1983	Long, Jr.	29/861

FOREIGN PATENT DOCUMENTS

921777	3/1963	United Kingdom	29/749
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Primary Examiner—Howard N. Goldberg
Assistant Examiner—Carl J. Arbes
Attorney, Agent, or Firm—Louis A. Hecht

[57] **ABSTRACT**

A method and apparatus for making an electrical harness. The harness generally includes at least one connector having a housing with insulation displacement type contacts loaded therein. Each contact is connected to an insulation clad multi-wire ribbon cable. The apparatus performs the functions of positioning a connector on a first station, holding the ribbon cable at a second station remote from the first station, moving the connector to the second station so that each contact is in alignment with each wire, moving the connector toward the ribbon cable so that each wire is simultaneously displaced into its corresponding contact, moving the connector back to the first station, holding the ribbon cable at the second station at the end of its length, cutting the insulation of a predetermined segment on the end of the length at the second station, cutting the ribbon cable held at the second station, imparting a longitudinal force upon the cut length of ribbon cable to pull the cable length from the second station and strip the cut insulation segment from the end thereof.

2 Claims, 10 Drawing Figures

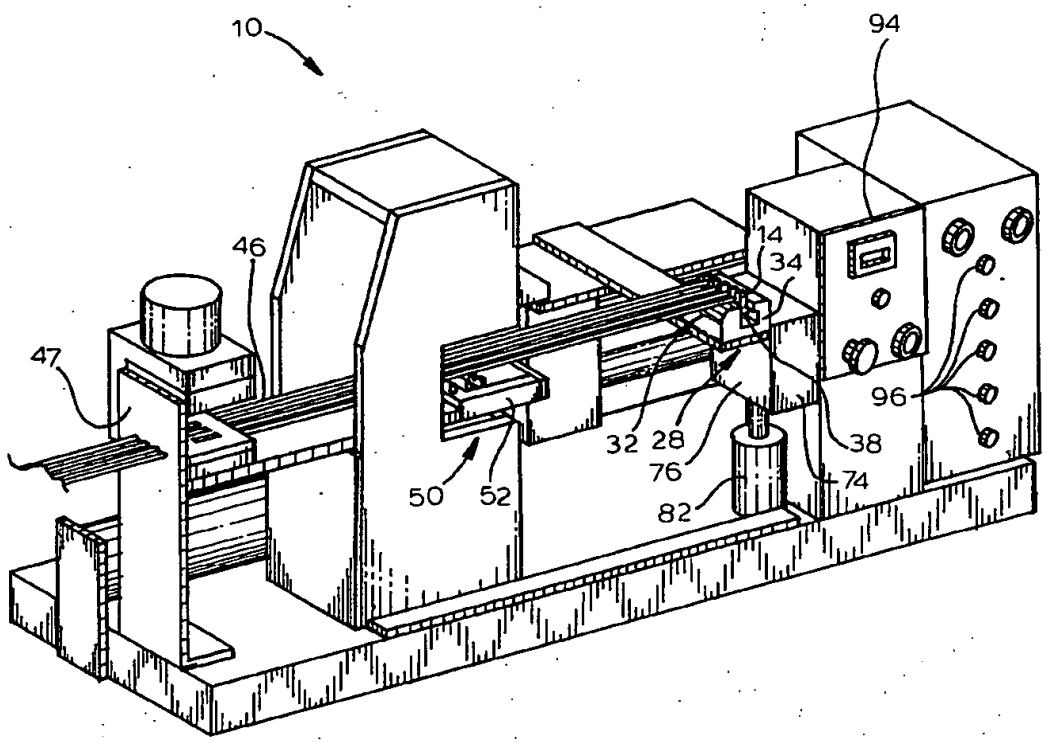

FIG. 1

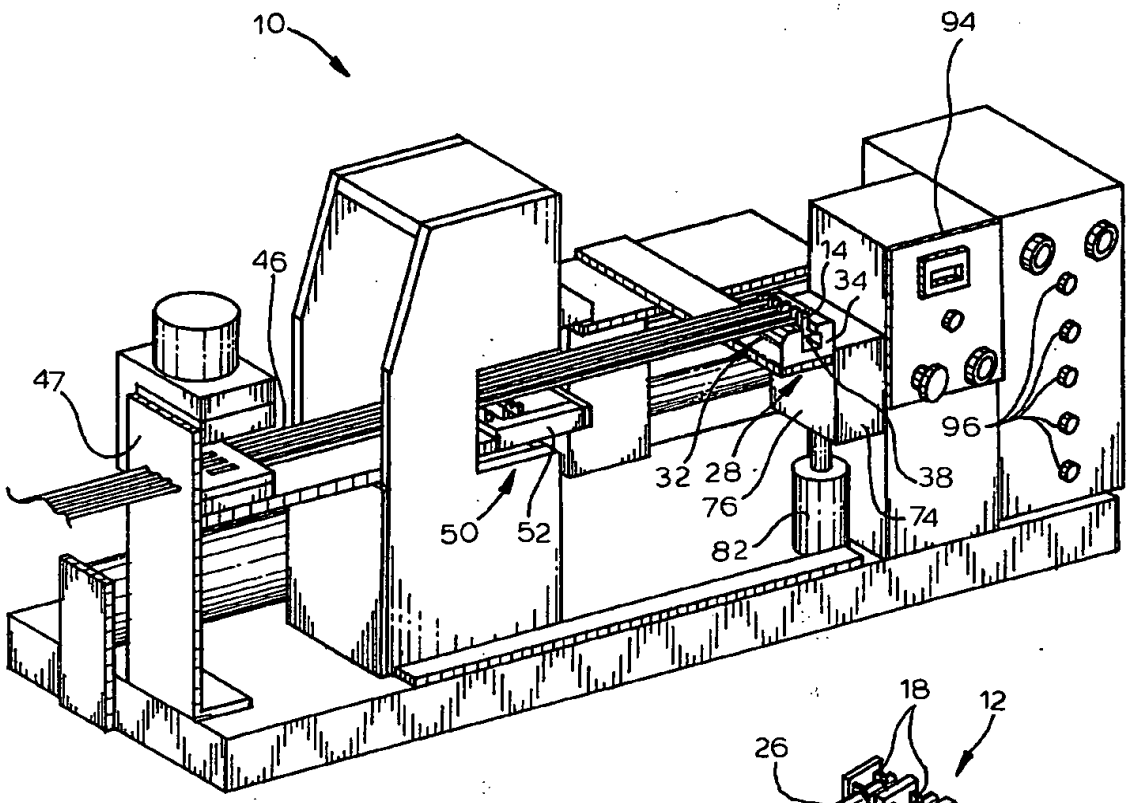
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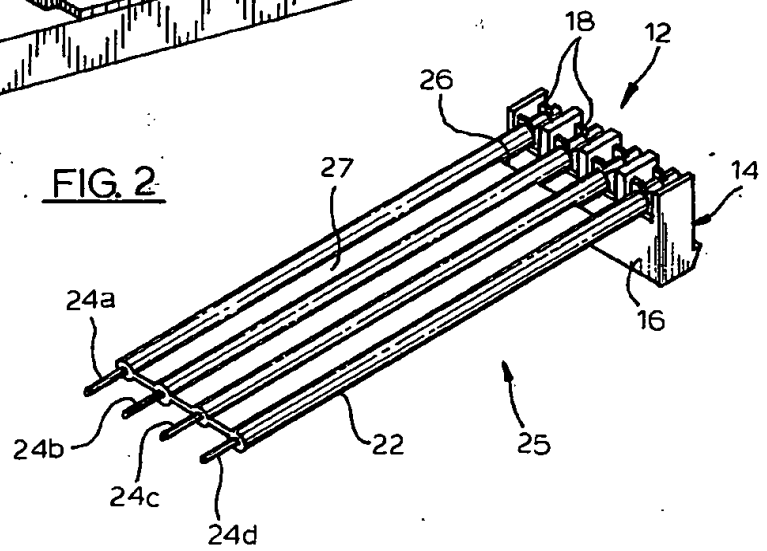
FIG. 2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12
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27
14
24a
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24b
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24c
24d

FIG. 3

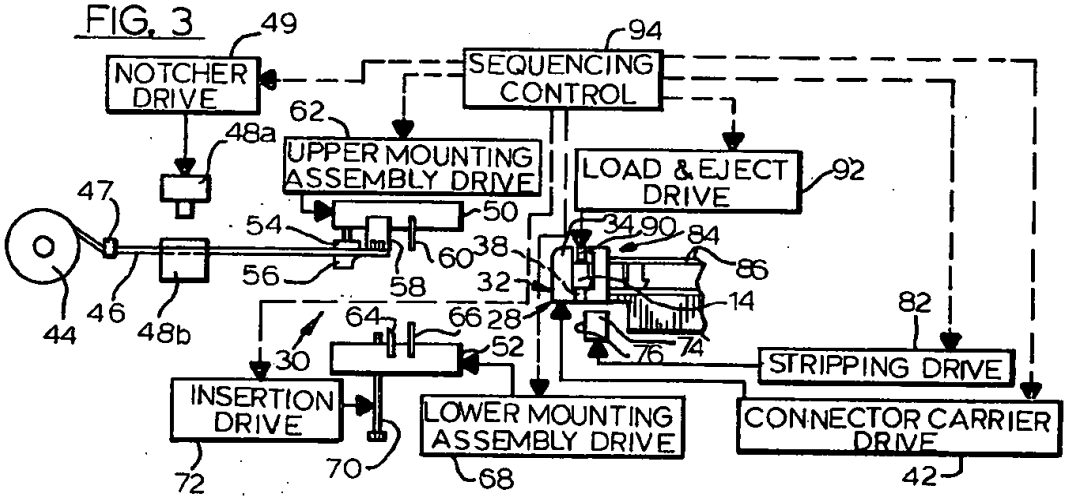


FIG. 4

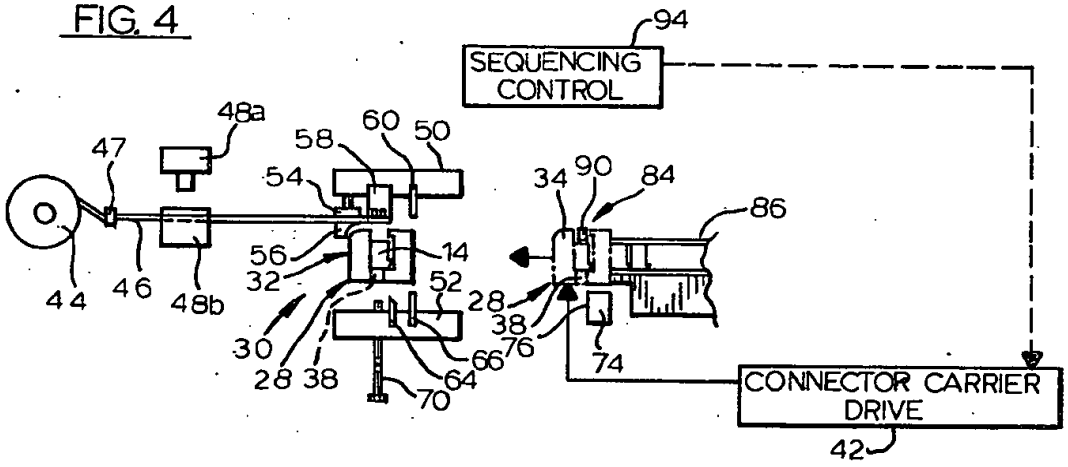


FIG. 5

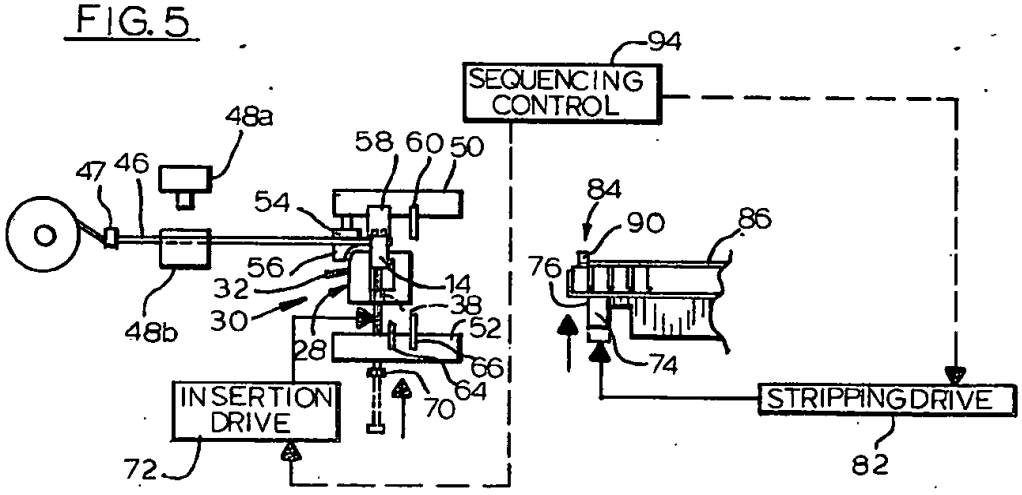


FIG. 6

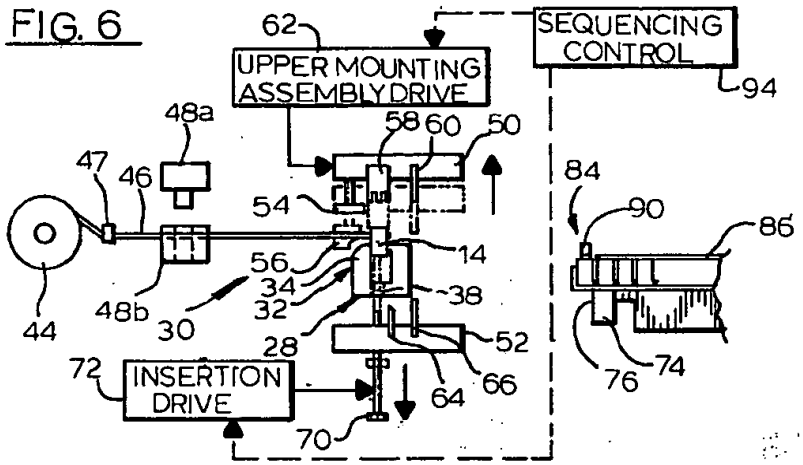


FIG. 7

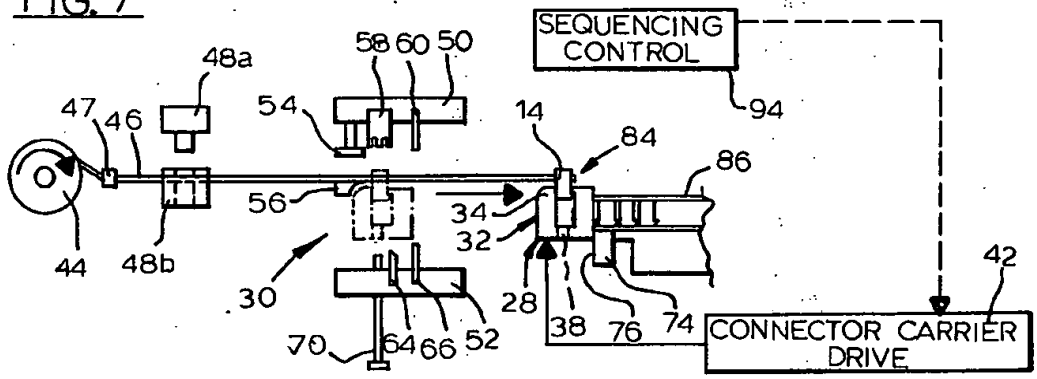


FIG. 8

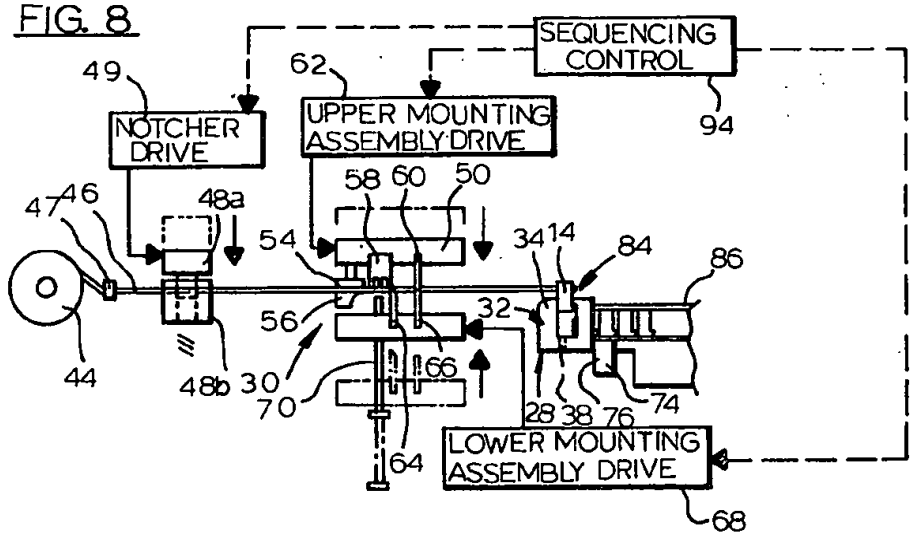
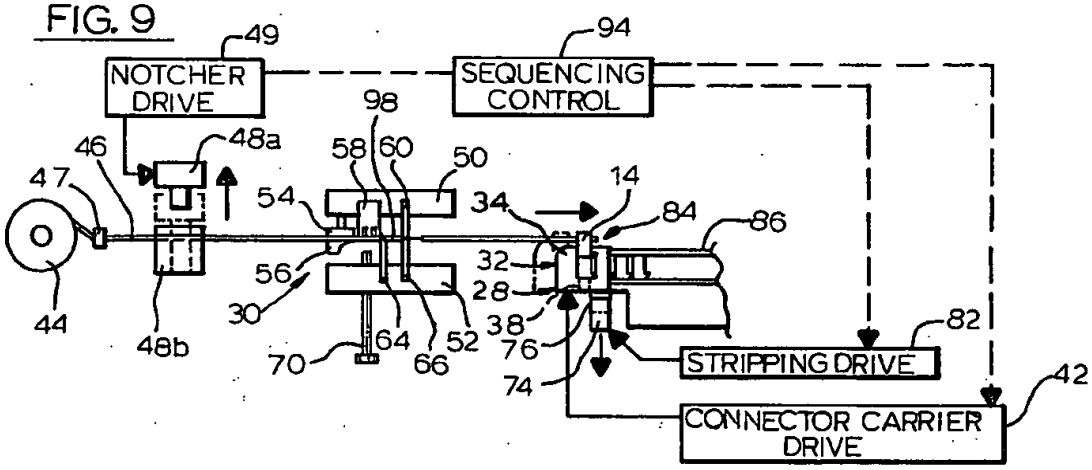


FIG. 9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NOTCHER DRIVE
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SEQUENCING CONTROL
98
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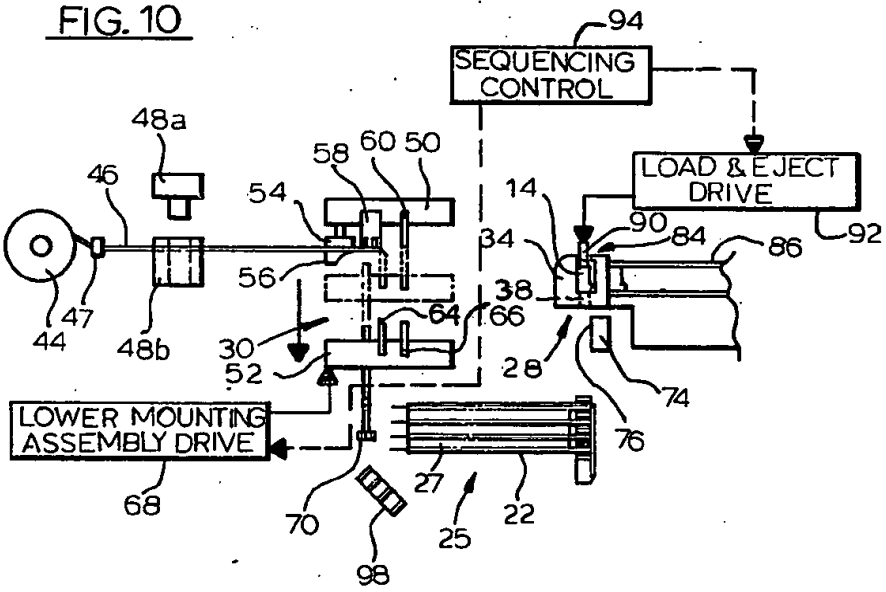
48a
58
60
50
47
54
34
14
84
86
32
56
28
30
38
82
44
48b
64
52
76
STRIPPING DRIVE
70
66
74
42
CONNECTOR CARRIER DRIVE

FIG. 10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60
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LOAD & EJECT DRIVE
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14
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92
84
86
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64
66
47
44
48b
30
28
52
74
LOWER MOUNTING ASSEMBLY DRIVE
76
27
68
70
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22
98

ELECTRICAL HARNESS FABRICATION APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to a method and apparatus for making electrical harness of the type including the connector having a housing with insulation displacement type contacts loaded therein, each contact connected to an insulation clad wire.

2. Brief Description of the Prior Art

The invention described and claimed herein is an improvement over the method and apparatus disclosed in U.S. Pat. No. 4,235,015 entitled "Electrical Harness Fabrication Method and Apparatus", dated Nov. 25, 1980 and assigned to the assignee of the present invention. The method and apparatus disclosed in said prior patent performs the following functions:

positioning a connector at a first station;

holding at least a number of wires corresponding to the number of contacts at a second station remote from said first station;

moving the said connector to said second station so that each contact is in alignment with each held wire;

simultaneously inserting each wire into its corresponding contact at the second station;

moving said connector back to said first station and simultaneously drawing a predetermined length of wire defined between said connector and said second station;

holding each wire at a second station at the end of the desired length;

cutting all held wires at the second station;

cutting the insulation of a predetermined segment on each end of the desired length at the second station; and

imparting a force upon said cut lengths of wire to pull said wire lengths from the second station and strip the cut insulation segment from each end thereof.

The machine for performing the method set forth above comprises:

a first station whereat a connector is initially position;

a second station remote from said first station;

holding means mounted at said second station for selectively gripping said wires;

insertion means mounted at the second station for simultaneously displacing each wire into its corresponding contact;

a connector carrier for mounting the connector thereon in a given disposition removable between said first station and said second station in alignment with said wires;

holding means mounted at said second station for selectively gripping said wires;

wire cutting means mountd at the second station for cutting the wires to the same length;

wire pulling means for imparting a force upon said cut lengths of wire for pulling said wire lengths from the second station and strip the cut insulation segment from each end thereof;

control means for sequentially actuating said insertion means, holding means, wire cutting means, connector carrier and wire pulling means in a given order, said control means moving said connector carrier from said first station to said second station, actuating said insertion means so that said wires are displaced in its corresponding contact, releasing said wire holding means, moving said connector carrier back to said first station drawing wire therewith, actuating said wire holding means, actuating the wire cutting means and the wire pulling means to form a completed electrical harness.

In the above mentioned U.S. Pat. No. 4,235,015, a looping assembly which forms loops of differing magnitudes in the wire lengths imparts an axial force upon the cut lengths of wire. In this manner, an electrical harness having different wire lengths can be effected.

Although a looping assembly can be used to produce an electrical harness having the same wire lengths, it can be appreciated that the size of such an assembly would be expensive to make and cumbersome to use for such a limited purpose.

SUMMARY OF THE INVENTION

It is, therefore, the principal object of the present invention to provide an improved method and apparatus for making electrical harness of the type comprising at least one connector having a housing with insulation displacement type contacts loaded therein each contact connected to an insulation clad wire of the same length. More particularly, it is the principal object of the invention to provide an improved method and apparatus of the type disclosed in U.S. Pat. No. 4,235,015 as described in detail above wherein all of the wire lengths are the same.

The improved method of performing the invention contemplated herein is characterized by imparting said force longitudinally on the wire in a direction away from said second station.

It is another object of the present invention to provide an improved machine to practice the improved method recited above. More particularly, the improvement comprising of the invention is a new means of imparting a force upon the cut lengths of wire which is characterized by:

a reciprocally mounted stripping block having a limiting surface defining the furthest limit of the first station away from said second station, said stripping block being movable between a first position in the path of travel of the connector carrier whereby the connector carrier would abut said limiting surface when at the first station and a second position out of the path of travel of the connector carrier whereby said connector would be able to travel past said first station in a direction away from said second station;

said control means moving the stripping block to its second position to allow the carrier to travel past said first station and exert a longitudinal force against said wires.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the machine of the present invention;

FIG. 2 is a perspective view of a completed electrical harness made according to the method and apparatus of the present invention;

FIGS. 3–10 are schematic flow diagrams illustrating the method of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Looking at FIGS. 1 and 3–10, the electrical harness machine, generally designated 10, of the present invention is shown. The machine 10 is intended to automatically produce a completed electrical harness, generally designated 12, as shown in FIG. 2.

Looking at FIG. 2, the electrical harness 12 is seen to generally include a connector, generally designated 14, comprising an insulated housing 16, having a plurality of insulation displacement type contacts 18 preloaded therein. Each contact has the usual insulation displacement type slot (not shown) which is adapted to slice through the insulation of insulation clad wire lengths 22 connected thereto. Each end of the wire lengths 22 has an exposed stripped conductor portion 24 thereon.

It is to be noted that the wire lengths 22 form a part of a ribbon cable assembly 25 depicted in FIG. 2. Instead of using a ribbon cable, the wire lengths could be discrete.

The ribbon cable 25 has notched sections 26 formed in the insulation webs 27 between wires 22. The purpose of the notched sections is to facilitate insulation displacement into the contacts 18.

The exposed conductor portions 24 are of the same magnitude as shown in FIG. 2. However, it is to be understood that the method and machine to be described hereinafter can be employed to make electrical harness wherein the exposed conductor portions are of differing magnitudes or wherein no exposed conductor is present at all. It is also understood that although a four circuit connector 14 is illustrated in the drawings, any size connector can be used.

Looking once again at FIGS. 1 and 3–10, the machine 10 is generally seen to include a first station, generally designated 28, and a second station, generally designated 30, remote from said first station. A connector 14 is initially positioned at the first station 28 and a finished electrical harness 12 is ejected therefrom later in the electrical harness fabrication operation.

The wires 22 are connected to the insulation displacement contacts at the second station 30. In addition, the end of the ribbon cable 25 is cut and stripped at the second station 30.

The connector 14 is positionable on a connector carrier, generally designated 32, which is movable between the first station 28 and the second station 30. The connector carrier 32 includes a generally U-shaped connector nest, generally designated 34, having an opening 38 formed in the bottom thereof for purposes which will become more apparent hereinafter. The nest 34 is adapted to move between the first station 28 and the second station 30 in response to a carrier drive 42.

A free rolling wire reel 44 is provided on the side of the second station 30 opposite the first station 28. The uncut cable 46 fed from the reel 44 is threaded through a wire guide 47 through a notcher 48*a* and 48*b*. The upper portion of the notcher 48*a* is adapted to move downwardly in response to a notcher drive 49 to produce the notched sections 26 formed in the insulation webs 27.

Looking at FIGS. 3–10, the second station 30 is seen to have an upper mounting assembly 50 and a lower mounting assembly 52. More particularly, each mounting assembly is movable between an "up" position and "down" position in response to an upper mounting assembly drive 62 and a lower mounting assembly drive 68, respectively.

In order to hold the cable 46 at the second station 30, there is provided wire holding means in the form of upper and lower wire gripping members 54 and 56, respectively. The upper wire gripping member 54 is secured to the upper mounting assembly 50 for movement therewith between its up and down positions. The lower wire gripping member 56 is stationary throughout all the operations of the machine 10. Thus, when the upper housing assembly 50 is in its down position, the wire gripping members 54 and 56 hold the cable 46 at the second station 30. When the upper mounting assembly 62 is in its up position, the wire gripping members 54 and 56 are spaced apart thereby releasing the cable 46.

Mounted adjacent the upper and lower wire gripping members 54 and 56 is an insulation displacement insertion blade 58 of a configuration well-known in the art. The insertion blade 58 is secured to the upper mounting assembly 50 for movement therewith.

A plurality of upper insulation cutting blades 60 are fixed on the upper mounting assembly 50 for movement therewith for cutting the insulation on the end of the cable 25. It is to be noted that the blades 60 are not only aligned with each circuit wire, but, as shown, are in the same longitudinal disposition with respect to one another. If, however, it is desired to strip different lengths of insulation, the blades 60 can be mounted in different longitudinal dispositions with respect to one another.

The lower mounting assembly 52 has a wire shearing blade 64 secured thereto for movement therewith. The shearing blade 64 is capable of cutting the cable when it is pinched between the blade and the side surface of the insertion blade 58. This occurs when the upper mounting assembly 50 is in its down position and the lower mounting assembly 52 is in its up position.

The lower mounting assembly 52 also has a plurality of lower insulation cutting blades 66 secured for movement therewith. Each of the lower insulation blades 66 is in alignment with the upper insulation cutting blades 60 and will cooperate to cut the insulation at the ends of the wire lengths 22 when the assembly is in its up position.

Connector moving means 70, which comprises a portion of the insertion means, is associated with, but not connected to, the lower mounting assembly 52. The connector moving means 70 is mounted for reciprocal movement between an "up" position and a "down" position and is adapted to engage a connector 14 at the second station 30 to move the connector upwardly toward the insertion blade 58. The connector moving means 70 is movable in response to an insertion drive 72.

A reciprocally mounted stripping block, generally designated 74, is located immediately adjacent the first station 28 on the side remote from the second station 30. The stripping block 74 has a limiting surface 76 which defines the furthest limit of the first station away from the second station. The stripping block 74 is movable in response to a stripping drive 82 between a first position and a second position. The first position occurs when the stripping block 74 is in the path of travel of the connector carrier 32 as is shown in FIG. 1. More particularly, the connector carrier 32 will abut the limiting surface 76 which prevents the carrier from moving further away from the second station 30. The second position occurs when the stripping block 74 is below and out of the path of travel of the connector carrier 32 as is shown in FIGS. 9 and 10. When the stripping block 74 is in the second position, the connector carrier 32 is able to travel past the first station 28 in a direction away from the second station 30.

Located adjacent the first station 28 is a load and eject assembly, generally designated 84. (Not shown in FIG. 1) The load and eject assembly 84 generally includes a connector magazine 86 which stores a plurality of connectors 14 for positioning, one at a time, at the first station 28. A push member 90 is provided to engage

a connector 14 and push it into the connector nest 34 after a completed electrical harness 12 is presented at the first station 28. At the same time the push member 90 loads the new connector 14 into the connector nest 34, the push member 90 engages the completed electrical harness 12 to eject it from the connector nest 34 in response to a load and eject drive 92.

In operation, a sequencing control 94 actuates each of the drives 42, 49, 62, 68, 72, 82 and 92 in a sequence which will produce the desired completed electrical harness 12. Several control buttons 92 (FIG. 1) can be provided to manually override or stop the sequence.

Initially, the machine 10 commences operation in the configuration illustrated in FIG. 3. At this point, the cable 46 from the wire reel 44 has been threaded through the wire guide 47 through the notcher 48*a* and 48*b* to the second station 30 whereat it is held by the upper and lower wire gripping members 54 and 56. The upper mounting assembly 50 is in its down position and the lower mounting assembly 52 is also in its down position. The connector nest 34 is at the first station 28 having a connector 14 loaded therein. The stripping block 74 is in its second position allowing the nest 34 to move somewhat to the right of the first station 28.

When the machine 10 commences operation, the connector nest 34 is moved from the first station 28 to the second station 30 as is shown in FIG. 4. The stripping block 74 is moved upwardly to its first position. The connector moving means 70 is then actuated so that it is received through the opening 38 in the connector nest 34 to engage and move the connector 14 upwardly toward the insulation displacement insertion blade 58 as is shown in FIG. 5.

The connector moving means 70 is then reciprocally retracted and the upper mounting assembly 50 assumes its up position. Because the upper mounting assembly 50 assumes its up position, the upper and lower wire gripping members 54 and 56 release the wire and the insertion blade 58 is lifted out of engagement with the cable 25 as is shown in FIG. 6.

It is to be noted that the connector 14, which originally was seated at the bottom of the nest 34, is now in a raised position because of the connection to the length of cable 25. The connector 14 assumes this raised position for the remainder of the harness making cycle.

As is shown in FIG. 7, the connector nest 34 is then moved from the second station 30 to the first station 28. Because the cable 46 is connected to the contacts 18, a length of cable is drawn from the reel 44 without any positive or power driving force applied to the cable itself. As a result, no sophisticated or extra mechanism is required to power feed the cable in order to measure out a given length which is defined between the connector 14 at the first station 28 and the shearing blade 64 at the second station 30.

In the next step of operation shown in FIG. 8, the upper and lower mounting assemblies 50 and 52 move toward each other so that the upper mounting assembly 50 is in its down position and the lower mounting assembly 52 is in its up position. This produces three results: (a) the upper and lower insulation cutting blades 60 and 66, respectively, cut the insulation on the end of the cable length 25 opposite the connector 14; (b) the insertion blade 58 and wire shearing blade 64 cooperate to cut the cable 25 at the end of the desired lengths; and (c) the upper and lower gripping members 54 and 56 hold the cable 46 preparatory to the next harness making cycle.

The stripping block 74 then actuated so that it moves to its second position disengaging the connector carrier 32 with the limiting surface 76. When this occurs, the connector carrier 32 is allowed to travel a short distance further away from the second station 30 imparting a longitudinal force on the cut cable length 35. As a result, the end of the cable length 25 is pulled out from the insulation cutting blade 60 and 66 stripping the insulation segment 98 therefrom and freeing the ends of the cable 25 from the second station 30 as is shown in FIG. 9. At this point, a finished electrical harness 12 is positioned in the connector nest 34. A new connector 14 has already been positioned adjacent the first station at a height lower than the connector 14 of the completed electrical harness 12.

Looking at FIG. 10, the last step of the harness making cycle removes the segment of insulation 98 from the second station. In addition, the load and eject assembly 84 is actuated by the load and eject drive 92 so that the push member 90 ejects the completed electrical harness 12 from the connector nest 34 and loads a new connector 14 into the connector nest 34. The machine 10 is now ready to repeat the cycle.

We claim:

1. In a machine for making an electrical harness, said harness comprising at least one connector with insulation displacement type contacts loaded therein, each contact connected to an insulation clad wire, each wire being of the same length, said machine including:

a first station whereat a connector is initially positioned;

a second station remote from said first station;

holding means mounted at said second station for selectively gripping said wires;

insertion means mounted at the second station for simultaneously displacing each wire into its corresponding contact;

a connector carrier for mounting the connector thereon in a given disposition removable between said first station and said second station in alignment with said wires;

holding means mounted at said second station for selectively gripping said wires;

wire cutting means mounted at the second station for cutting the wires to the same length;

wire pulling means for imparting a force upon said cut lengths of wire for pulling said wire lengths from the second station and stripping the cut insulation segment from each end thereof;

control means for sequentially actuating said insertion means, holding means, wire cutting means, connector carrier and wire pulling means in a given order, said control means moving said connector carrier from said first station to said second station, actuating said insertion means so that said wires are displaced in their corresponding contacts, releasing said wire holding means, moving said connector carrier back to said first station drawing wire therewith, actuating said wire holding means, actuating the wire cutting means and the wire pulling means to form a completed electrical harness.

the improvement in said wire pulling means comprising:

a reciprocally mounted stripping block having a limiting surface defining the furthest limit of the first station away from said second station, said stripping block being movable in a path of travel generally transverse to the path of travel of the path of the connector carrier between a first position in the

path of travel of the connector carrier whereby the connector carrier would abut said limiting surface when at the first station and a second position out of the path of travel of the connector carrier whereby said connector carrier would be able to travel past said first station in a direction away from the second station; and

said control means moving the stripping block to its second position to allow said connector carrier to travel past said first station and exert a longitudinal force against said wires.

2. The machine of claim 1 wherein said wires are joined together by webs of insulation to form ribbon cable and further including wire notching means for selectively removing portions of the webs of said cable prior to the actuation of said wire insertion means.

* * * * *

US005208977A

United States Patent [19]

Ricard

[11] Patent Number: 5,208,977

[45] Date f Patent: May 11, 1993

[54] **PROCESS FOR THE CONNECTION OF CONDUCTOR WIRE OR OPTICAL FIBER SECTION ENDS TO CONNECTORS**

[76] Inventor: **Claude Ricard**, Villa Ste Magdeleine 52 Cours GAMBETTA, 13100 Aix En Provence, France

[21] Appl. No.: 777,697

[22] Filed: Oct. 17, 1991

[30] Foreign Application Priority Data

Oct. 17, 1990 [FR] France 90 13137
Oct. 17, 1990 [FR] France 90 13138
Oct. 17, 1990 [FR] France 90 13139

[51] Int. Cl.[5] A01R 43/04

[52] U.S. Cl. ..... 29/861; 29/857; 29/33 F; 29/33 M

[58] Field of Search ..... 29/748, 857, 861, 33 F, 29/33 M

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4,581,796 4/1986 Fukuda et al. ..... 29/748 X
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5,083,369 1/1992 Cerda 29/857

Primary Examiner—Carl J. Arbes
Attorney, Agent, or Firm—Browdy and Neimark

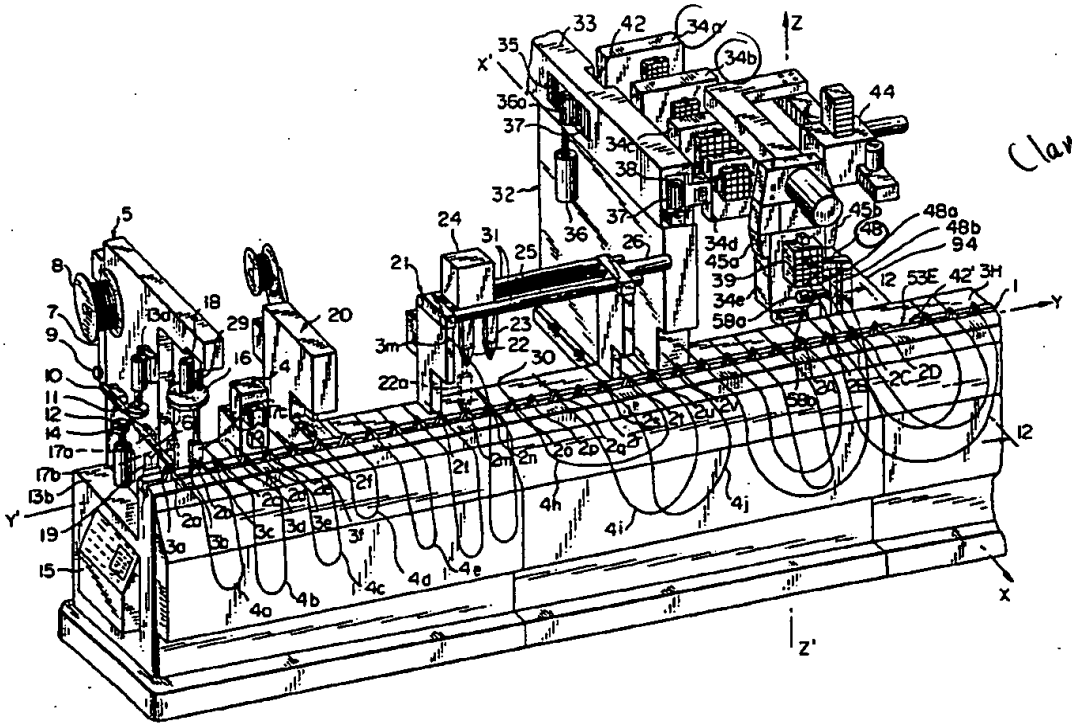
[57] ABSTRACT

The object of this invention is processes and devices for the automatic connection of conductor wire or optical fiber section ends to adapted component receptacles using clamps of various types and having specific uses.

A device according to the invention comprises a conveyor (1) which feeds clamps to various end processing units. Loading unit (5) positions wire sections in a first type of clamp (2). Units (4), (20) modify the ends for purposes of their connection. Unit (21) interchanges the ends in clamps to arrange them in a preferential order for the connection which is subsequently performed by one or more units (32). The invention uses clamps adapted to a variety of operations, to hold a group of wires (72) or to hold components (34).

An application is the automatic production of conductor wire bundles.

14 Claims, 10 Drawing Sheets



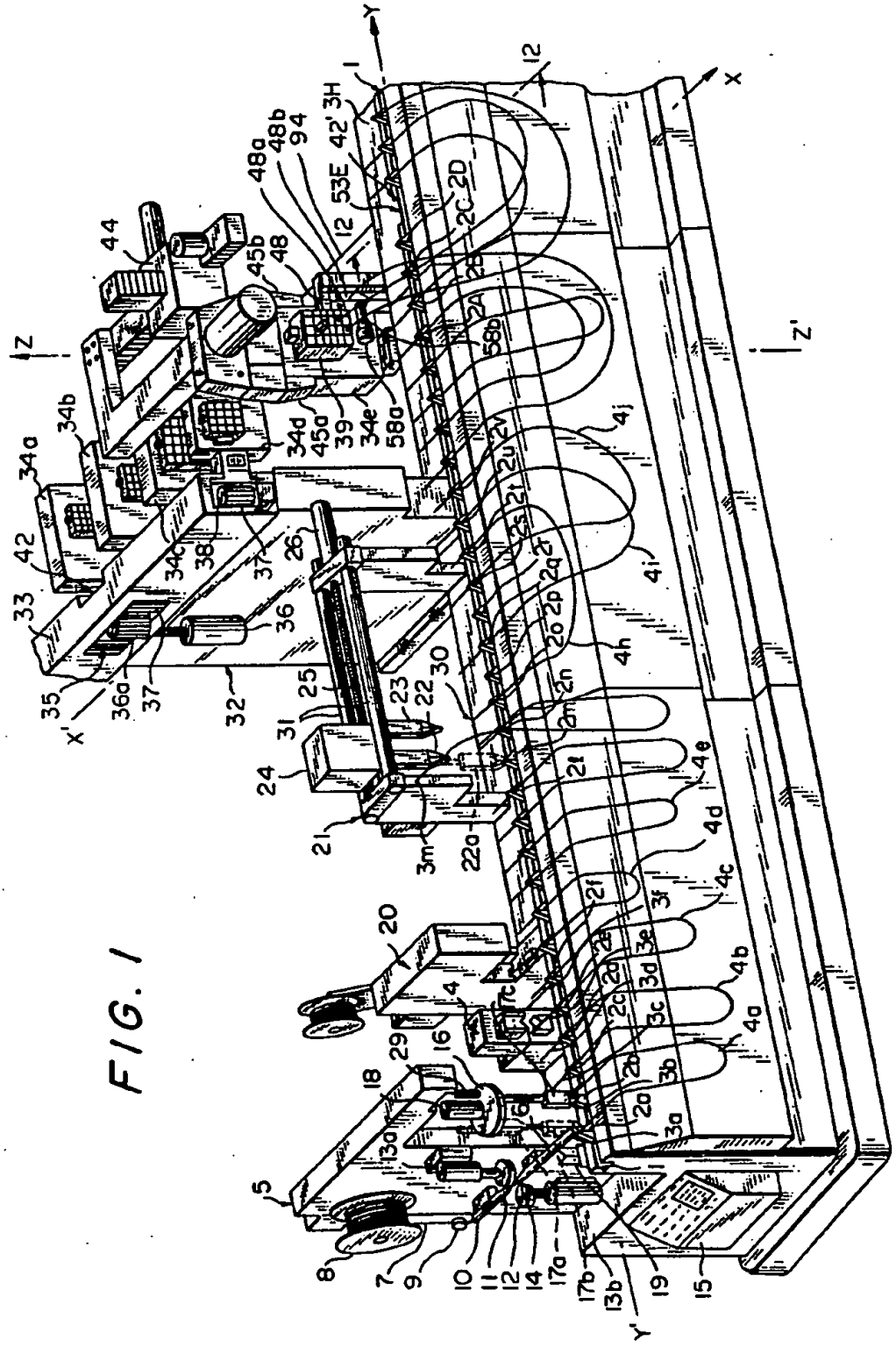


FIG. 1

FIG. 1A

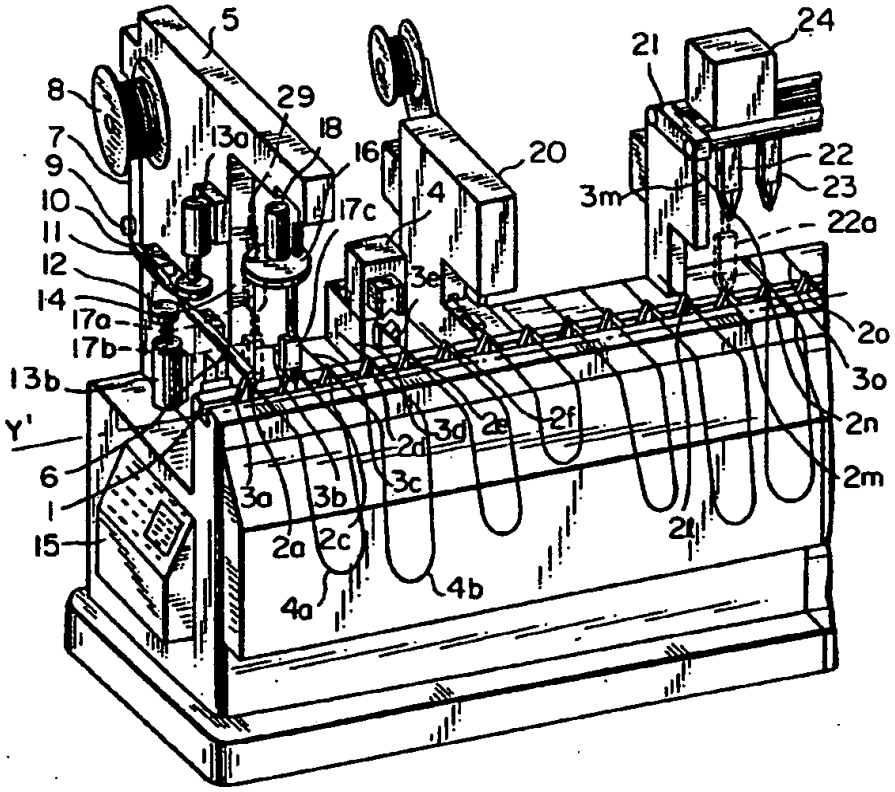

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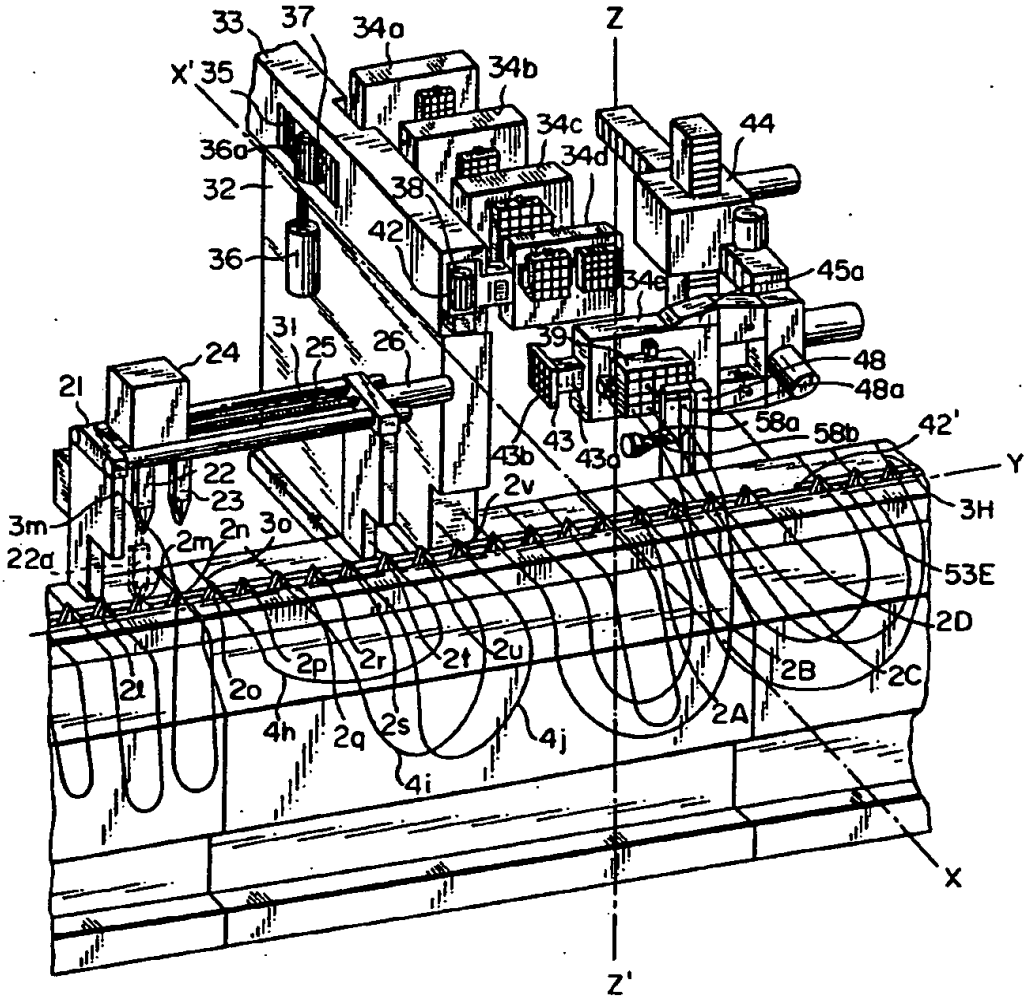
FIG. 1B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2n
3o
22a
2m
53E
2D
2p
2r
2t
2u
2B
2C
2l
2o
4h
2q
2s
4j
2A
4i
X
Z'

FIG. 2

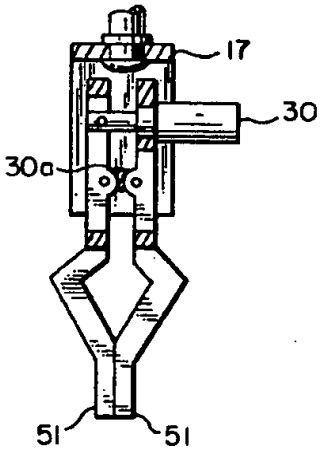


FIG. 3

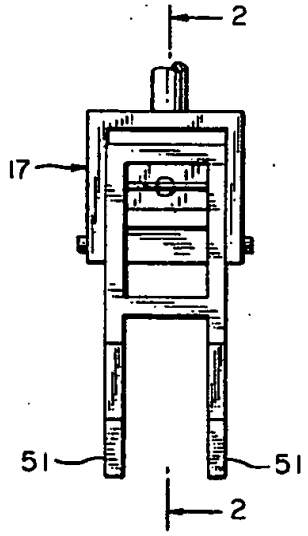


FIG. 4

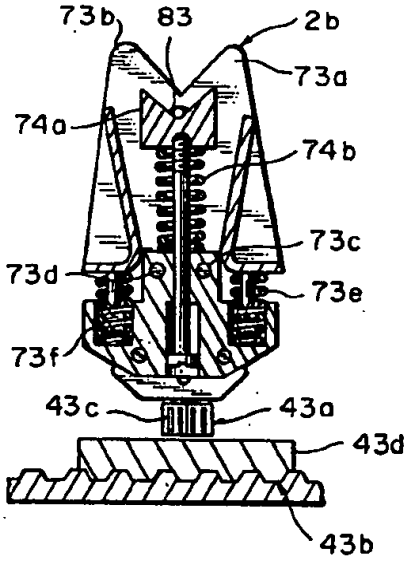


FIG. 5

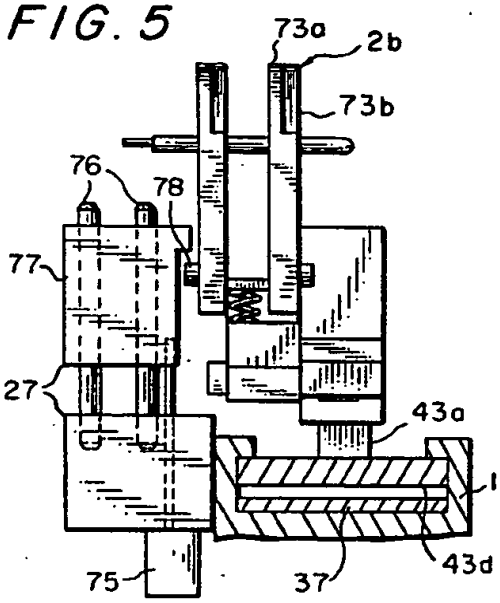


FIG. 6

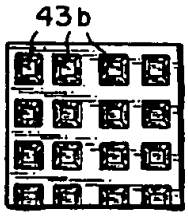


FIG. 7

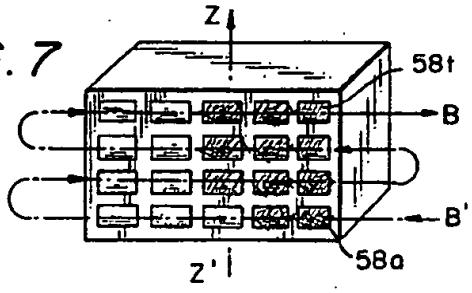


FIG. 8

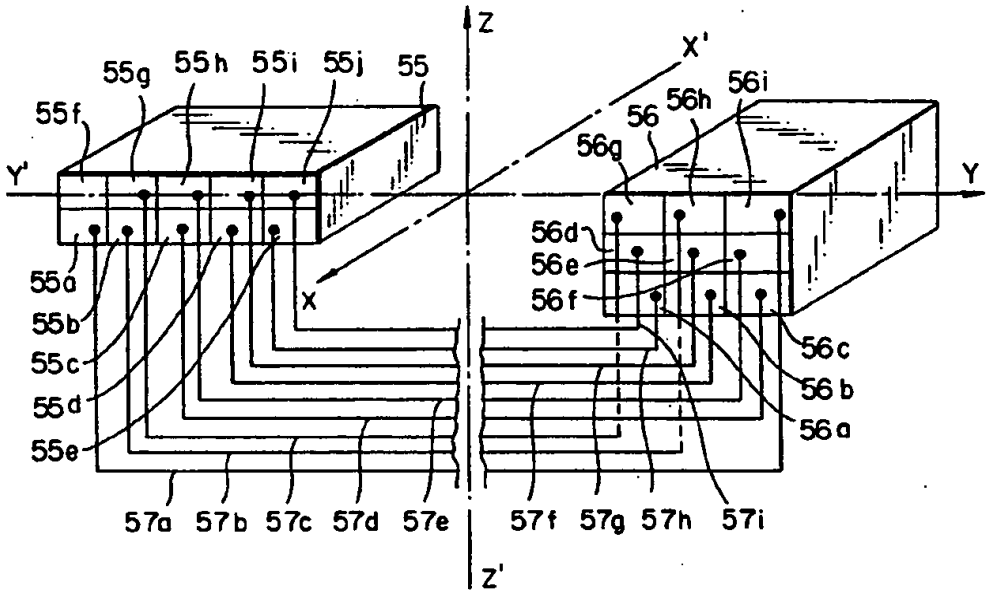
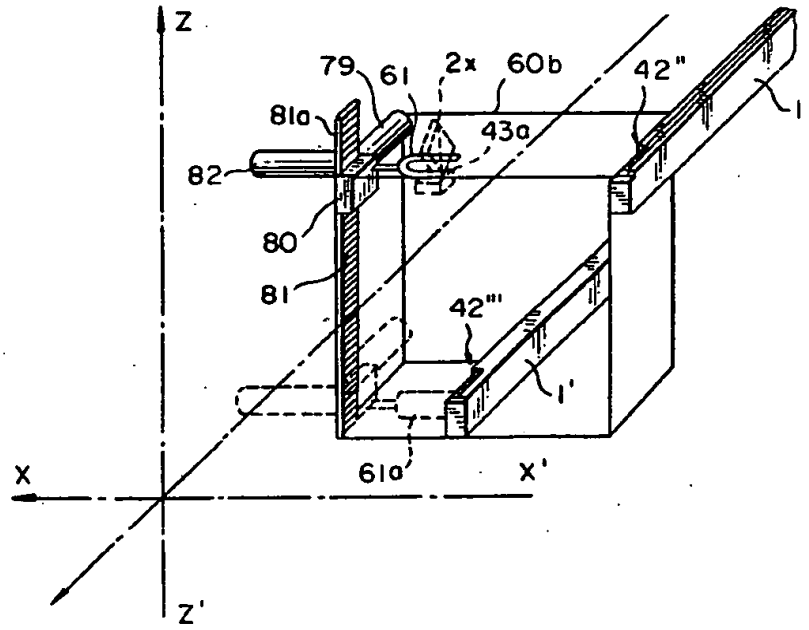

Z
X'
55g
55h
55i
55j
55
55f
56i
56h
56
56g
Y'
Y
56d
56e
56f
55a
55b
55c
55d
55e
X
56c
56b
56a
57a
57b
57c
57d
57e
57f
57g
57h
57i
Z'

FIG. 11


Z
79
61
2x
60b
42"
1
81a
43a
82
80
81
42'''
1'
X
61a
X'
Z'

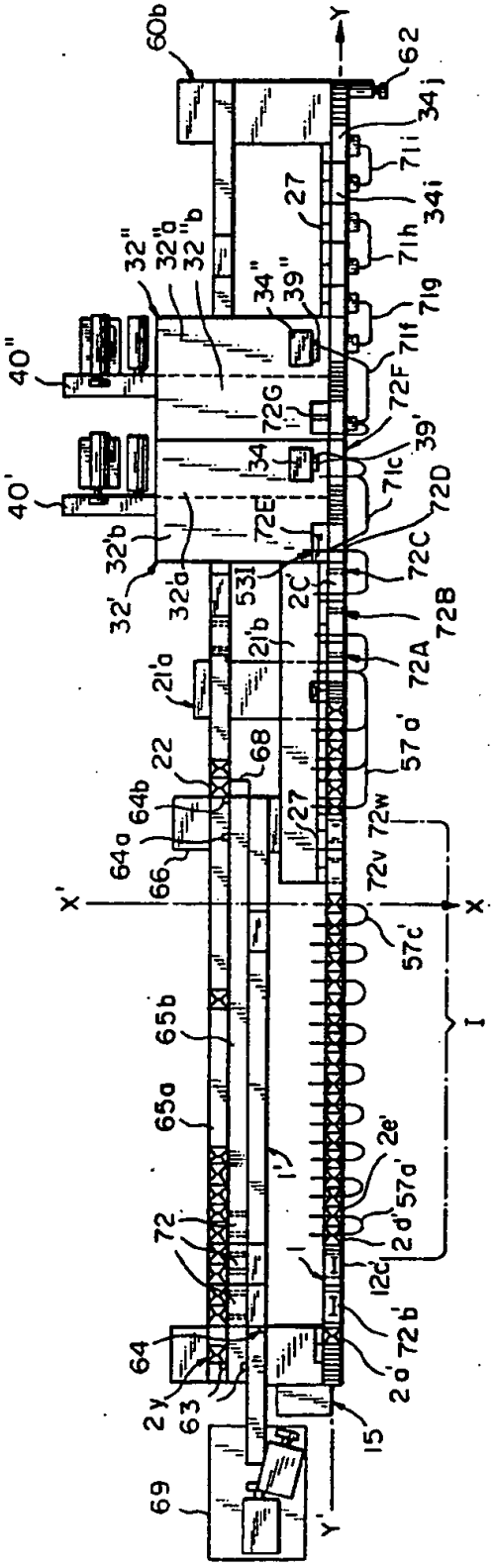

60b
Y
62
34j
71i
34i
71h
71g
71f
72F
39'
71c
72D
72C
72B
72A
57a'
72W
72V
57c'
I
65b
65a
2e'
57d'
2d'
12c'
72b'
2a'
15
Y'
69
63
2y
64
72
1'
66
64a
64b
22
68
27
X'
X
2c'
21b'
21a'
32'
32'b
32'a
531
72E
72G
34
39
40'
40"
32"
32"a
32"b
34"
39"
27

FIG. 9

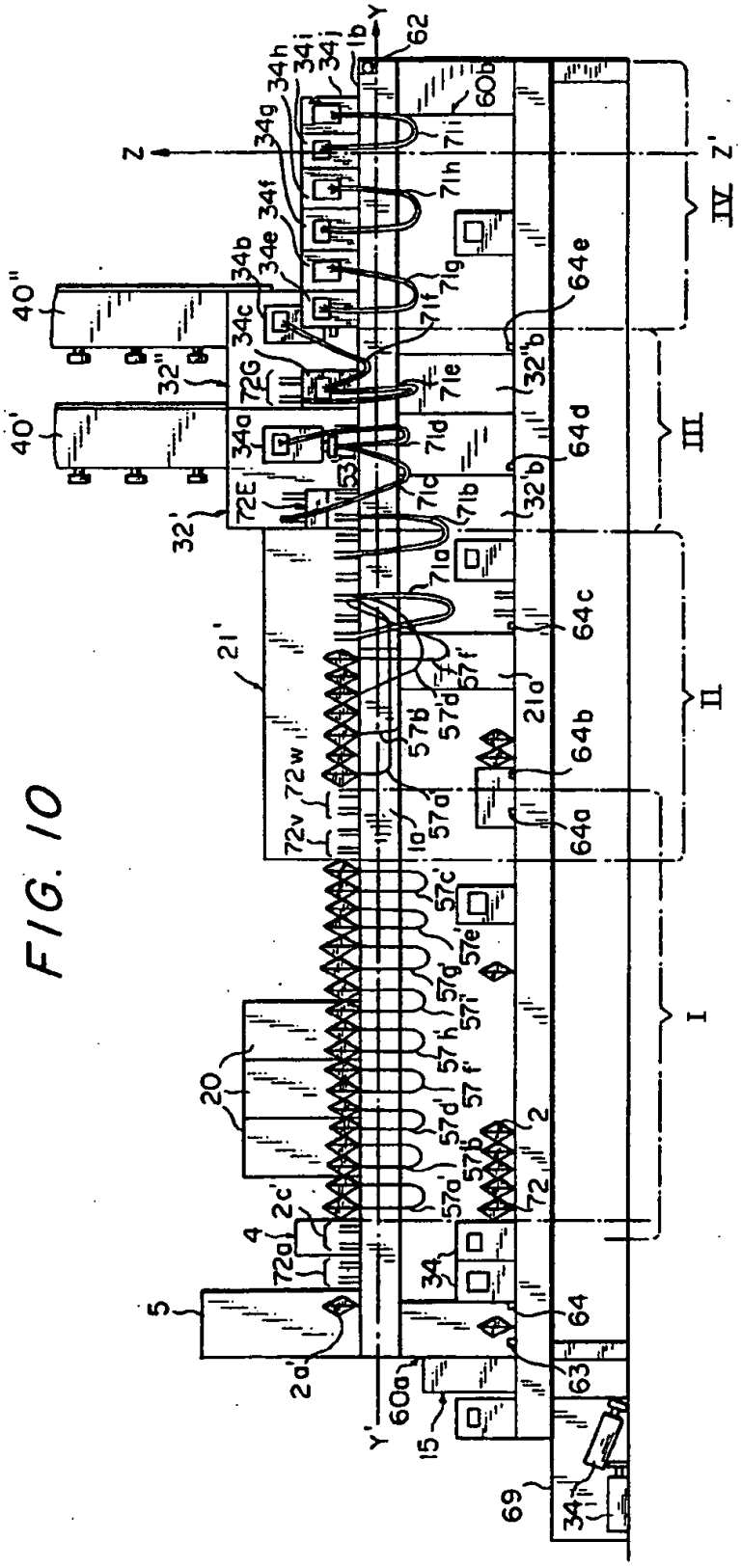


FIG. 10

FIG. 13

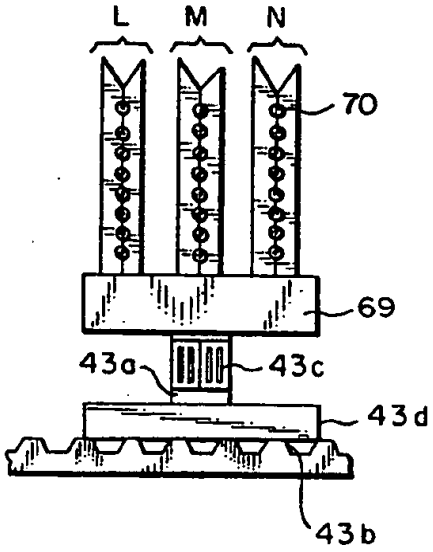


FIG. 14

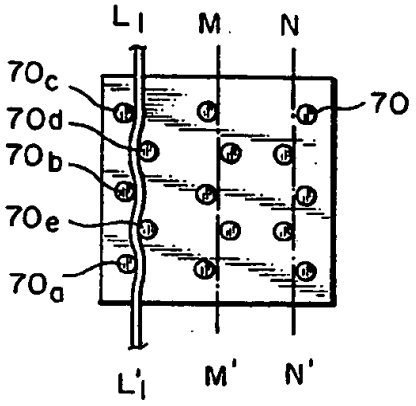


FIG. 12

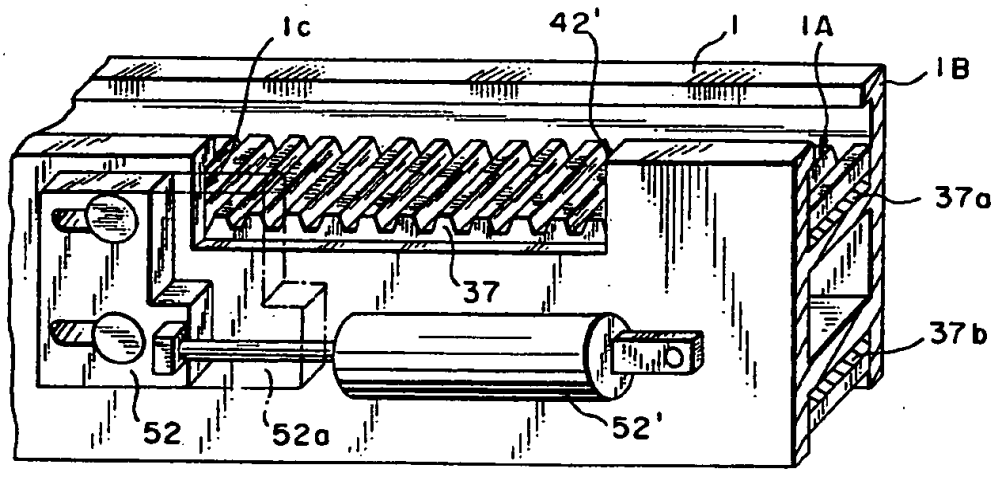


FIG. 15

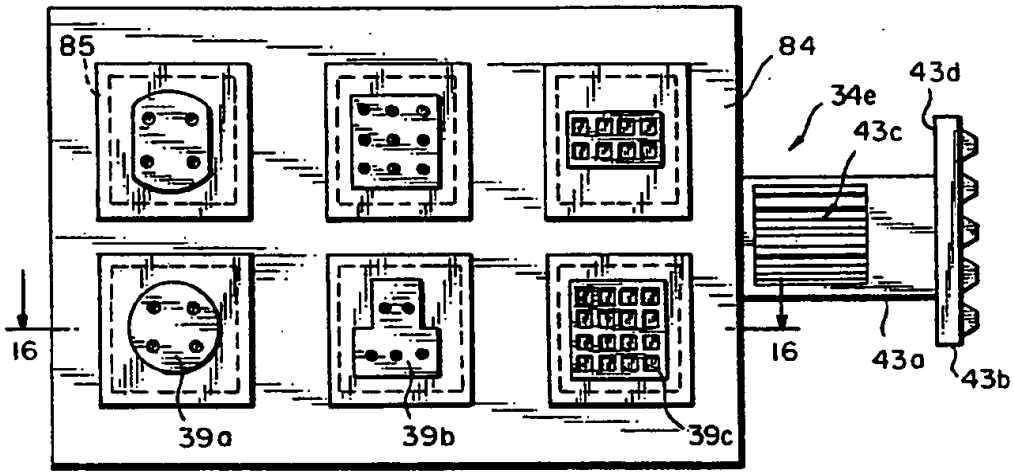


FIG. 16

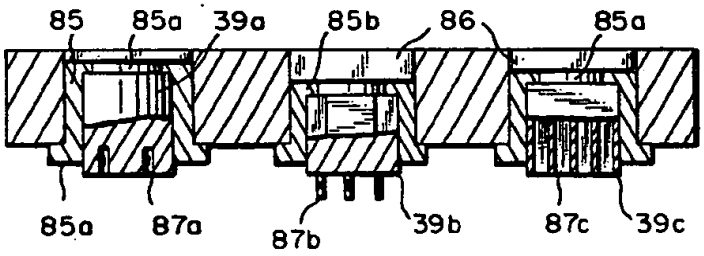


FIG. 17

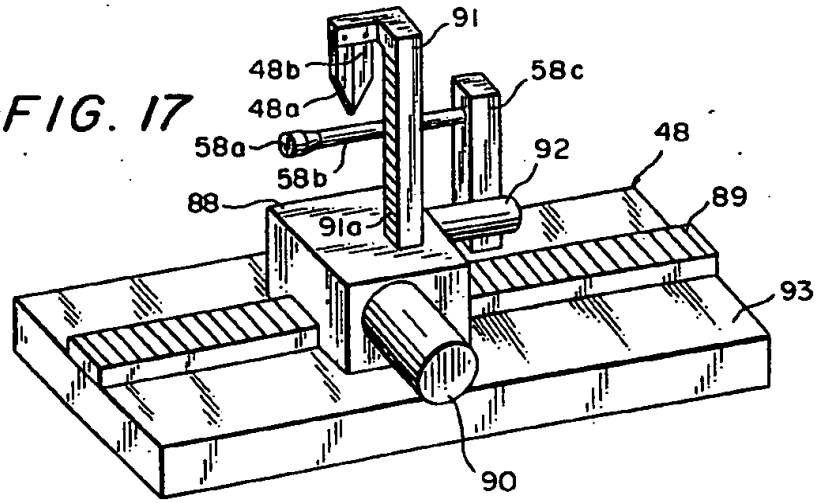


FIG. 18

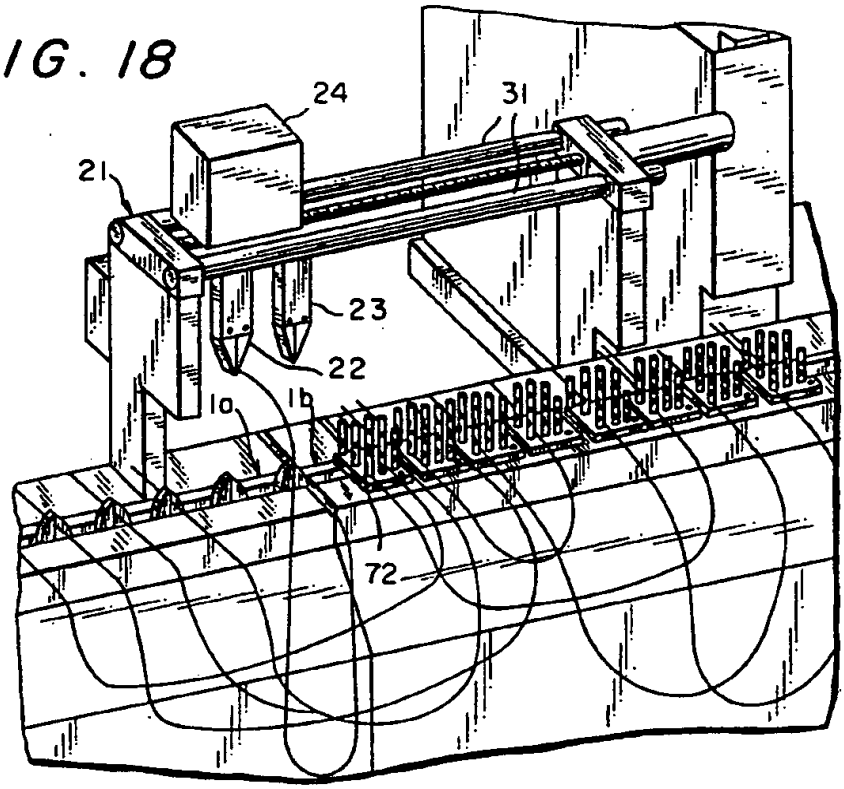
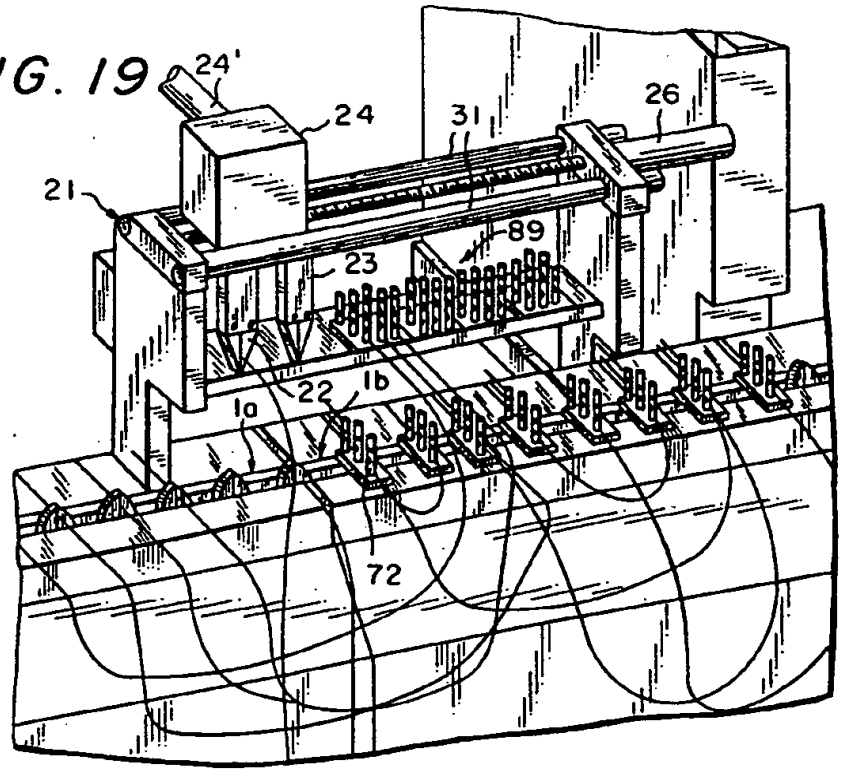


FIG. 19



PROCESS FOR THE CONNECTION OF CONDUCTOR WIRE OR OPTICAL FIBER SECTION ENDS TO CONNECTORS

The object of this invention is processes and devices for the automatic connection of conductor wire or optical fiber ends to adapted component receptacles.

The invention is in the technical sector of automatic wiring machine construction.

Patent Application FR 86 16777/2,607,652 filed on Nov. 28, 1986 describes processes for automatically inserting connectors crimped on the ends from a lot of conductor wires coming out of an automatic wiring machine into the sockets of insulating housings or conductive terminals.

French Patent Application FR 87 11391 / 2,619,258 filed on Aug. 17, 1987 and U.S. Pat. No. 4,715,099 (YOSHIDA) of Dec. 29, 1987 describe wiring machines wherein several conductor wires are transported by clamps which are placed on a conveyor incorporated into an automatic wiring machine, said clamps each holding one end of a wire section. FR-A-2619258 also describes the making of conveyors and clamps.

French Patent FR-A-2,555,397 describes another type of automatic machine and a connection device for simple bundles shown in FIGS. 7-11..

The above-cited patents define wiring machines wherein:

- A conveyor endowed with clamps to grasp and hold conductor wire ends is transferred by intermittence;
- Said ends are grasped, held, and transferred by intermittence along a given transfer path using said clamps of said conveyor;
- Said clamps are used to feed some of said ends to end processing units arranged laterally along said transfer path: loading unit, stripping unit, crimping unit, etc.;
- If applicable, said ends are modified using said end processing units.
- Said machines are controlled by a programmable central computer. They automatically cut sections of wires whose length is determined by the program. They strip some of said section ends and automatically perform crimping operations.

These patents do not teach how to make wiring machines capable of constructing complex bundles comprising a wide range of different connectors.

The automatic mutual insertion of two rigid mechanical parts, male and female, is known in the field of mechanical parts assembly. However, where wiring machines are concerned, these operations are different and become complex when not involving two rigid mechanical parts, but instead a set of flexible wires to be connected in a limited area.

Connecting the first wire is a delicate operation owing to the small clearances involved, but this operation is performed in a perfectly known context.

However, when the first wire is connectorized, it becomes an obstacle to the automatic connection of the subsequent ones, and the encumbrance increases for the connection of the subsequent wires because of the entanglement of the wires which have already been connectorized.

This results in numerous collisions of the ends, which interrupts operations owing to ends which strike against

wires which have already been inserted, which jams the automatic machine and makes it less productive.

Furthermore, the wire ends are generally endowed with connectors which are usually crimped, and said connectors become damaged in collisions with wires which have already been inserted, leading to a lower quality level.

This makes known automatic machines unreliable and limits their use to particular bundles in which no collisions occur: parallel bundles or very simple bundles which use connectors having only one layer of contacts, such as in French Patent FR-A-2,555,397. Said particular bundles only represent a minority, and the other bundles, known as complex bundles, are not processed automatically.

The solution to this problem which has been proposed in the prior art cited above is not effective for bundles comprising a great variety of connectors, which is generally true for complex automobile bundles.

Processes or devices for performing some necessary operations such as interchanging wires or arranging a set of ends in a given order, for example, must also be invented or improved.

One object of this invention is the construction of automatic wiring machines which perform the automatic connection of conductor wire or optical fiber section ends to connectors, whose productivity and quality levels are not reduced by the collisions of ends against wires which have already been connected.

Another object of this invention is to to build automatic wiring machines as described above which can process complex bundles.

Another object of the invention is to enable the automatic connection of ends endowed with the widest variety of connectors.

The process according to the invention provides

- A conveyor endowed with clamps to grasp and hold said ends;
- Said ends are grasped, held, and intermittedly transferred along a given transfer path using said clamps of said conveyor;
- If applicable, said clamps are used to feed some of said ends to end processing units arranged laterally along said transfer path;
- If applicable, said ends are modified using said end processing units. The objects of the invention are reached using a process wherein clamps of various types and having specific uses are placed on said conveyor.

Advantageously, some of said clamps make it possible to grasp and hold several wires in a given order and in a limited space.

Advantageously, said clamps can be separated from said conveyor and can be engaged mechanically thereon or withdrawn mechanically therefrom.

Also, according to a preferred process:

- Said ends are fed to an interchange unit which is placed laterally along said transfer path, and the order of some of said ends on said conveyor is modified using said interchange unit;
- Said clamps are used to feed several of said ends to at least one connection unit placed laterally along said transfer path downstream from said interchange unit, and which comprises means to take a given end and connect it to one of said connectors of the component or components clamps which it is processing;

And, using said connection unit, some of said ends are taken in said clamps on said conveyor, and are connected to some of said connectors in a predetermined manner, taking them in an order which can be different from the order in which said ends are fed to said connection unit.

Advantageously, some of said clamps make it possible to grasp and hold several wires in a given order and in a limited space.

Advantageously, in a process according to the invention to produce bundles, all of the components of the same branch of a bundle are grouped together on one or more component clamps.

Other specific objects in making the interchange unit, which is a subunit of this complex invention, are reached using a process according to which some wires are transferred temporarily to a standby position so that they can be subsequently taken up and arranged in a predetermined order.

Advantageously, said clamps can be separated from said conveyor and can be engaged mechanically thereon or withdrawn mechanically therefrom.

Advantageously, to make wiring bundles and to enable the automatic interconnection of several connectors of different electrical components with conductor wire or optical fiber sections, several connection units are arranged laterally along said transfer path.

The object of the invention is reached using clamps of various types and having specific uses intended for the automatic connection of conductor wire or optical fiber section ends to connectors, which can be transported by the same conveyor, separated from said conveyor, and which can be mechanically engaged thereon or withdrawn therefrom, wherein they comprise all of the same means to interface with said conveyor and have an automatically-legible inscription making it possible to identify the type.

A result of this invention is the construction of wiring machines, primarily an automatic wiring machine, enabling the automatic connection of conductor wire or optical fiber section ends with the connect of an electrical component, which are in disarray, and, in this way, making it possible to process most bundles.

Said first result enables the automatic assembly of bundles or interconnections and makes it possible to avoid most operating interruptions owing to ends which strike against wires which have already been inserted. Said first result also enables the automatic assembly of bundles or interconnections while avoiding the deterioration in quality of a final product caused by damage to connectors during automatic connection resulting from the collisions of said connectors on already-inserted wires.

Another result of the invention is that it enables the automatic connection of ends endowed with widest variety of connectors.

The interchange unit has two gripping components, thus providing a temporary storage unit, and, in this way, two ends are moved in one round trip movement, which takes less time than two consecutive movements.

This invention also makes the following possible:

Making bundles which require the simultaneous connection of more components than one component clamp can hold;

Organizing the groups of wires connected to the components of the same component clamp more effectively, preventing any untimely knotting or crossing of the wires from different branches, and grouping all of the components in the same branch of a bundle on one or more component clamps.

Limiting the number of housings which must be fed simultaneously on one or more connection units, because this makes it possible to connect different housings successively, thus reducing the required number of connection units and the number of components on the same component clamp, thereby reducing the cost of the wiring machine and increasing its flexibility.

Manufacturing more complex bundles and automating numerous manual tasks, while improving productivity and quality.

The description below makes reference to the accompanying drawings, which,, on a purely non-restrictive basis, show a sample embodiment of a device according to the invention and various types of clamps designed to equip it.

FIG. 1 is a partial perspective view of a device according to the invention:

FIG. 1A shows a portion of the device in FIG. 1.

FIG. 1B shows another portion of the device of FIG. 1.

FIGS. 2 and 3 are respectively, a transverse section along section line B—B of FIG. 3 and an elevation view of a loading clamp.

FIGS. 4, 5, and 6 are respectively, a transverse section of an end clamp, an elevation view of said clamp and the accompanying opening device, and bottom view of the base of said clamp.

FIG. 7 illustrates a preferred insertion order.

FIG. 8 shows a bundle for which the production process is determined as an example.

FIGS. 9 and 10 are respectively, a top view and an elevation view of a device according to the invention in the process of manufacturing a bundle.

FIG. 11 is a perspective view of an embodiment of a loading system.

FIG. 12 is a view of the locking system associated with a cut-out in the conveyor.

FIGS. 13 and 14 are an elevation view and a top view of one of the group clamps.

FIGS. 15 and 16 show a front view and a transverse section of an embodiment of a component clamp according to the invention.

FIG. 17 is a perspective view of an embodiment of the connection manipulator from one perspective.

FIGS. 18 and 19 are a partial perspective view of the interchange unit.

FIG. 1 shows that conveyor (1) is endowed with clamps (2*a*), (2*b*), (2*c*), (2*d*), etc. to grasp and hold the ends such as (3*a*), (3*b*), (3*c*), etc. of wire sections such as (4*a*), (4*b*), (4*c*), etc. A wire section can be an electrical conductor as well as an optical fiber.

Said clamps, which make it possible to transport said ends along a given transfer path, are advantageously placed at regular intervals on the conveyor.

The computer (15) has positioned a variety of clamps (2*a*) and (2*b*) on conveyor (1) using the loading device, as shown in FIG. 1.

FIG. 1 shows that some clamp locations such as (53E) remain vacant and that some clamps such as (2*p*) do not hold wire ends. Some empty clamps are advantageously intended to be used to grasp ends transferred by interchange unit (21) from other clamps and some locations are left empty for the later placement of special clamps of a type other than is used to grasp and hold wire ends, such as shown in FIG. 15 and 16.

Conveyor is moved intermittently in equal steps, which generally represent the interval between two clamps, and in this case, end (3e) fed by clamp (2e) to end processing unit (4) is replaced by subsequent end (3d). In this way, stripping unit (4) can strip two consecutive ends. The conveyor (1) thus transfers all of the clamps it holds in the downstream direction.

The transfer is made intermittently in order to allow the different units to perform predetermined and specific actions under the control of computer (15) on the ends fed to them by conveyor (1) which is also under the control of the computer (15), such as placing the ends of wire sections having predetermined lengths in clamps for loading unit (5), such as modifying the ends for stripping unit (4) or crimping unit (20), such as changing the order of some of said ends on said conveyor by interchange unit (21), and such as the connection of components to some receptacles in a predetermined manner for a connection unit such as (32).

FIG. 1A shows a sample embodiment of unit (5) or loading unit which places the wire sections in the clamps. Wire (7) runs from spool (8) to return pulley (9) into a first tube (10) between two frictional wheels (11) and (12) which sandwich it, and finally into a second telescopic tube (14), section (6) of which represents the retractable part.

When the positioning of wire section (4a) begins, the transfer is in the position shown, but clamp (2a), which is in the axis of tube (14) whose retractable coaxial tube (6) is retracted and clamp (2b) are empty.

Using opening mechanisms activated by a jack (75) shown in FIG. 5 and not visible in FIG. 1, programmable computer (15) opens said clamps and takes out retractable tube (6) which slides between the open arms 72a and 73b of clamp (2a).

The computer activates motors (13a) and (13b) whose movements are synchronized and which drive frictional wheels (11) and (12), and thus unrolls a given length of wire which protrudes from tube (6). Then the computer orders the manipulator (16) whose loading clamp (17) shown in FIGS. 2 and 3 in greater detail is opened by jack (30) (FIG. 2) and moves downward from resting position (17a), shown in FIG. 1, to a first intermediary position (17b) also shown in FIG. 4, grasps the protruding end of wire using jack (29), moves back up to position (17a), then is rotated 180° around the axis of motor (18) and moves in a vertical translation into the second intermediary position (17c). During all of these movements, the computer controls motors (13a) and (13b) to unroll the wire in order to supply the wire needed to enable these movements to take place and to unroll the predetermined length of the section.

Loading clamp (17) FIGS. 2 and 3 holds the first end, or the downstream end of wire 4a, in position (17c) between its fingers (51) of loading clamp 17 and between the open arm 73a and 73b of end clamp (2b) as shown in FIGS. 4 and 5. This end is grasped by said clamp (2b) whose arms (73a) and (73b) are closed again by the computer, which next orders manipulator (16) to open the loading clamp 17 and return it to position (17a).

The computer next orders tube (6) to go back into tube (14), and clamp (2a) which grasps the second end of wire 4a to close. The computer then orders cutting clamp (19), shown in FIG. 1, to cut wire (7) at the retracted end of tube (6) thus creating the second end of wire (3a), or the upstream end of this section, and completes the positioning of wire section (4a) whose ends are held by clamps (2a) and (2b) with which conveyor (1) is endowed.

The ends are transferred along a transfer path which is rectilinear in this non-restrictive example (a circular conveyor would produce a circular path) to be fed to the various end processing units located along the transfer path of conveyor (1).

FIG. 1 shows that consecutive ends are fed in this way to various end processing units (4) and (20) arranged laterally along the transfer path of conveyor (1) so as not to impede the transfer of the ends, even if some parts of said units may overhang the transfer, such as the gripping components of interchange unit (21), for example.

The computer changes said ends in a predetermined manner using said end processing units by stripping some ends with the stripping unit (4) and crimping some of the connector ends using crimping unit (20) as shown in FIG. 1 as a nonrestrictive example.

In the special case in which the wire is an optical fiber, the processing units modify the ends by polishing them, stripping them, and by placing joining pieces on them.

The computer transfers and then feeds said ends to an interchange unit (21) which is placed laterally along said transfer path as shown in FIG. 1.

According to the advantageous sample embodiment in FIG. 1, the ends are held horizontally and all of the processing units are placed transversely on the same side of the transfer path, while the wire sections are placed on the other side, although this arrangement is strictly non-limitative, and according to another equally-advantageous sample embodiment, the ends would be held vertically and the sections would hang downward in alignment. This alternative solution is advantageous for holding the wire and limits problems caused by the waste created while the ends are being processed, which does not fall into the units located underneath at that time.

According to the advantageous sample embodiment in FIG. 1, which is described above, the wire sections are cut and placed in clamps on the conveyor (1) by loading unit (5), then the ends are modified by other units such as stripping unit (4), crimping unit (20), or any other unit placed upstream in this manner from interchange unit (21), conveyor (1) thus transferring the modified ends to the interchange unit.

According to another embodiment of the invention, the wire sections are cut and the ends modified without using conveyor (1) and units shown in FIG. 1, for example, manually, and the ends in this case can be fed manually or using a commercially-available manipulator endowed with at least one loading clamp (17), for example.

As shown in FIG. 1, the interchange unit modifies the order of the ends on the conveyor. The order of the ends upstream from the interchange unit is such that the wire sections are held one after the other. No ends of one section overlap the ends of another section, as shown in FIG. 1: sections (2a), (2b), (2c), (2d), (2e), and (2f).

As shown in FIG. 1, in the zone where the ends are fed to the interchange unit, clamps (2m), (2n), (2o), (2p), (2q), (2r), and (2s), the order of the ends was modified. The downstream ends of the three sections (4h), (4i), and (4j) were grouped in three consecutive clamps (2t), (2u), and (2v). The ends are rearranged.

FIG. 1 is a sample embodiment of interchange unit (21), which is a first manipulator endowed with at least one gripping mechanism (22) and (23), and a mechanism making it possible to move the unit from one point of said conveyor to another.

Gripping mechanisms (22) and (23) are the same type as that of loading clamp (17) with two jacks of the same type as (29) making it possible to move gripping mechanisms (22) and (23) up and down as shown in FIG. 9. Clamps (2*m*) and (2*n*), shown in FIG. 1A corresponding to gripping mechanisms (22) and (23), are associated with individual opening mechanisms, (27) shown in FIG. 5, but not shown in FIG. 1. Jacks (29) are advantageously electrical to allow movement downward to a variety of levels to get ends at different levels in the group clamp as shown in FIG. 13.

As shown in FIG. 1B the second part of this mechanism 21 is of the screw-nut type. Motor (26) drives endless screw (25) in rotation and the nut mounted on mobile unit (24) drives said unit (24) in translation, guided in a conventional manner by rails (31) parallel along the conveyor (1) so that the gripping components (22) and (23) move perpendicularly to the transfer path.

This enables the first manipulator or interchange connector (21) to grasp an end held by one of the clamps of conveyor (1) using each of said gripping mechanisms (22), (23) in the zone of action, or one of clamps (2*m*) to (2*s*), then to open said clamp and release said end from said clamp which becomes empty, then to move and engage said end in another empty clamp of conveyor (1).

In this way, according to FIG. 1, under the control of computer (15), said first manipulator or the interchange connector (21) can take end (3*m*) using gripping component (22). For this purpose, the computer opens and lowers gripping component (22) to lower position (22*a*) shown in phantom lines in FIGS. 1, 1*a* and 1*b*, closes it by activating jack (30) (FIG. 2) to grasp end (3*m*) held by clamp (2*m*) of the conveyor, then opens said clamp (2*m*) while raising the closed gripping component to the upper position (22) of gripping mechanisms shown in solid lines in FIGS. 1, 1*a* and 1*b*, releases said end of said clamp which becomes empty. These actions are is shown in FIG. 1.

Next, according to this example, the computer moves mobile unit (24) which holds gripping mechanism (22), (23) using endless screw (25), activating motor (26) to position component (22) perpendicularly to empty clamp (2*p*). At this time, it engages end (3*m*) in said empty clamp of conveyor (1), opening clamp (2*p*) using the opening device associated therewith, lowering the gripping mechanism to the lower position, closing the arms 73*a* and 74*b* of clamp (2*p*) on the end which is then grasped and held by said clamp (2*p*), opening the gripping component and moving it to an upper position.

If clamp (2*p*) is a group clamp, as shown in FIG. 13, it is not necessary to order it to open because the wires are held by deformation; instead, gripping mechanism 22 or 23 must be ordered to a predetermined level because the wires are arranged at different levels as shown in FIGS. 13 and 14.

This end having been transferred, the computer can use the same method to order another end to be transferred.

It is advantageous to have two gripping components as shown in FIG. 1, which makes it possible to move two ends in one round-trip movement, which takes less time than two consecutive movements. Another advantage is that one of the components can be used as a temporary storage mechanism for one end; in this way, if end (3*m*) held by clamp (2*m*) must be interchanged with end (3*o*) held by clamp (2*o*), the computer can order gripping component (22) to take end (3*m*), order gripping component (23) to take end (3*o*), order gripping component (22) to place end (3*m*) in clamp (2*o*), and finally to place end (3*o*) in clamp (2*m*).

It is advantageous to use several gripping mechanisms (22), (23) because the movements are reduced, which accelerates the action of the interchange unit.

FIG. 1 shows a wiring machine wherein the computer uses said clamps to transfer and feed several of said rearranged ends to at least one connection unit (32) placed laterally along said transfer path downstream from said interchange unit (21) and which comprises means to take one of said ends and connect it to one of said connectors 39 of the component clamps 34 it is processing, and under the control of computer (15) shown in FIG. 1, using said connection unit, some of said ends are taken into said clamps on said conveyor and connected to some of the connectors in a predetermined manner, said ends being taken in an order which may be different from the order in which they are fed to said connection unit. FIG. 1 shows a non-restrictive sample embodiment according to which at least one second manipulator (32) known as a connection manipulator is placed laterally along the transfer path downstream from the first manipulator or interchange connector (21).

FIG. 1 shows an advantageous variation of the process, according to which several of said second manipulators are placed along the transfer, only the first of which is shown on the partial view in FIG. 1. In the part which is not shown, conveyor (1) is continued and a second manipulator is placed in the same way as the first one. Said second manipulator connects the ends not connected by the first, such as (3H). Advantageously, several connection units are arranged laterally along said transfer path to make cable bundles and to interconnect automatically several connectors of various electrical components with conductor wire or optical fiber sections. This configuration makes it possible to make bundles which require the simultaneous connection of more connectors 39 than one component clamp can hold. Another advantage of this solution is that the implementation of several connection units allows a more effective organization of the groups of wires connected to the connectors on the same component clamp 34 and makes it possible to move toward the solution of using one component clamp per bundle branch. This arrangement prevents any untimely knotting or crossing of wires from different branches.

Advantageously, the production of bundles can be arranged by grouping all of the components of the same bundle branch together on one or more component clamps of the type shown in FIGS. 16 and 16.

According to a particular embodiment, said device according to the invention comprises an overall control device which controls the operation of said connection units so that said conveyor feeds an end corresponding to one of the particular connection units to said particular connection unit in response to a first signal emitted by said overall control device and said particular connection unit takes said end and connects it to a particular connector in response to a second signal emitted by said overall control device, and such that the ends which do not correspond to said particular connection

unit skip said particular connection unit. According to a first advantageous embodiment, said overall control device is incorporated into the computer (15) software, which issues said signals, and according to a second embodiment, the previous embodiment is combined with a data transmission network and a conventional programmable robot on each of the connection units. The robot receives data in an appropriate coded form, and uses it to generate all or part of said signals according to an adapted program.

According to FIG. 1, a second conveyor (33) transverse to conveyor (1), of the known type having a synchronous belt such as conveyor (1) transports a set of clamps of the type which grasp and hold a component (34a), (34b), (34c), (34d), shown in detail in FIGS. 16 and 16, which are known as component clamps.

FIGS. 1, 15, and 16 show sample embodiments of component clamps. As shown in FIG. 15, component clamp (34e) comprising a base (43d) whose bottom surface is endowed with teeth (43b) forming two racks along axes parallel to X'X and Z'Z; FIG. 6 provides a sample embodiment of (43b) of said base (43d). Teeth (43b) can also mesh with the teeth of the synchronous belt (37) of the second conveyor (33) as well as with those of the synchronous belt with which the first conveyor (1) is endowed.

In the example in FIG. 1, axis Z'Z is vertical, axis Y'Y is horizontal and parallel to the first conveyor (1), and X'X is also horizontal. These three axes are perpendicular in pairs.

An operator manually engages the different component clamps one by one at the upstream end of conveyor (33). For this purpose, he slides base (43d) into cut-out (43), engaging in a vertical movement, the apex of the teeth (43b) of the base (43d) in the complementary shape of the synchronous belt (37) formed by the space between two teeth; the identical complementary form details of the base (43d) and the belt (37) are shown in FIG. 4. After a clamp (34) has been positioned, the conveyor transfers clamp (34a) to (34b) which allows the operator to slide a second component clamp into place through cut-out (42). This operation can be advantageously automated using a removable component clamp loader and a computer-controlled mechanism which positions them individually. In this way, the operator only intervenes to change said loader in which several component clamps are stacked.

Motor (36) drives the toothed pinion (36a) which is solidary with its axis and which meshes on synchronous belt (37) along the X'X axis. Said pinion and belt are shown in FIG. 1 through aperture (35) in conveyor (33). Said belt is stretched and rolls at its two ends over two wheels such as wheel (38). Computer (15) orders said motor to move the synchronous belt and the clamps it drives until a clamp is transferred to the front end of (33) conveyor at the level represented by component clamp (34d).

According to the embodiment in FIG. 1, the front end of the conveyor (33) is open so that the clamp located in front can move out.

FIG. 1 shows a sample embodiment of the third manipulator (44) which is a manipulator of a known type, having three degrees of freedom in translation along the three axes, X'X, Y'Y, and Z'Z, which can be the rack and pinion type as shown schematically, and one degree of freedom in rotation around an axis parallel to X'X.

The computer orders said third manipulator to grasp in its empty jaws (45a) (45b) the clamp transferred to the front end of the second conveyor at the level shown by component clamp (34d). It then orders said third manipulator to move along axis X'X synchronously with conveyor (33) long enough to release the base (43d) from the teeth of belt (37). In this case, the third manipulator command is the only one maintained to bring said component clamp into position (34e) in FIG. 1, making two translations along YY' and X'X and one rotation causing the component clamp (34e) to rotate 90° around an axis parallel to X'X in order to bring its base (43d) to horizontal position, with teeth (43b) downward.

FIG. 1 shows a sample embodiment of manipulator (48) shown in greater detail in FIG. 17, which can alternatively be a commercially-available manipulator. Jaws (48a) and (48b) are held by said manipulator (48) which makes it possible, under the control of the computer, to take one end out of one of clamps (2A), (2B), (2C), (2D), or (2E) and to feed it in a fixed position opposite the component clamp so that the axis of said end is parallel to the X'X axis.

The function of the component clamps shown in FIGS. 1, 15, and 16 is to grasp and hold at least one connector so that the axes of the component clamps (34) are directed along the X'X axis.

The computer moves connector (39) which is held by component clamp (34e) along the Y'Y and Z'Z axes, in order to align the connector (39) corresponding to the end held by the manipulator (48) and then inserts this end through a movement along the X'X axis in order to insert and connect the end with the connector positioned opposite it.

The connector is predetermined according to the end, and can be one of a number of connectors held in the component clamp placed in the field of action of said connection manipulator, i.e., one of the connector, held by clamp (34e) which itself is held by jaws (45a) and (45b).

The computer then issues commands so that jaws (48a) and (48b) release the end which has just been connected, and the third manipulator retracts so that another end-connecting cycle can resume, after having advantageously folded the plugged-in wire downward as will be discussed below.

When the last end to be connected to the connector or connector, carried by component clamp (34e) held by jaws (45a) and (45b) is connected, the computer orders the third manipulator to position the component clamp on conveyor (1) by sliding base (43d) in a movement along X'X, on synchronous belt conveyor (1) in the same way as it had been slid on synchronous belt (33). Said component clamp is positioned through cut-out (42') in the area (53E) which the computer left open on conveyor (1). For this purpose, the computer did not load any other clamp at this location.

FIG. 12 is a partial detailed rear view along an AA section of the release (42') performed on conveyor (1) at the clamp (2E) in FIG. 1 for the positioning of the component clamp on the conveyor. This release is identical to the release (42) performed on conveyor (33).

As shown in FIG. 12, belt (37) has the same width as the side of base (43d) which is advantageously square. The thickness of base (43d) is such that it is trapped between belt (37) and parts 1a) and (1b) of the conveyor.

The cut-out is located along the circulation path in which are trapped the bases which are driven by the

active cable of belt (37a) whose slack cable circulates in the lower part of the conveyor.

A lock (52) is able to move in translation. It is activated by the jack (52') fixed on the lock one side, and on the conveyor on the other side, and moves into position (52a) to block aperture (42) partially and to prevent the bases from coming out. The inside vertical edges of cut-out (1c) are beveled to prevent jamming.

In this non-restrictive sample embodiment of the invention, conveyor (1) advantageously transports clamps of different types, and advantageously in a process according to the invention, said conveyor transports a variety of types of clamps.

The manipulator (48) shown in FIGS. 1 and 17 comprises a complementary device to keep wires which have already been connected out of the way of ends still circulating on the conveyor. This device comprises a rod (58b) which ends with a cylindrical stop (58a). According to the example embodiment in FIG. 1, the wires which are already connected are held by rod (58b) well above the ends which are circulating underneath so as not to get in their way. Stop (58a) prevents the wires from sliding when manipulator (48) is moved along the Y'Y axis and the length of rod (48b) is at least equal to the amplitude of said movement. When the latter end has been inserted into the components held by component clamp (34e), manipulator (44) is moved so that the connected wires pass above manipulator (48).

According to an advantageous embodiment, computer (15) orders the interchange unit to arrange the ends in an advantageous order which makes it possible to simplify manipulator (48) by eliminating the movement along the Y'Y axis and maintaining only a fixed movement along the Z'Z axis, which is advantageously achieved in this case through the use of a jack. Manipulator (48) in this case is the same type as manipulator (16) or (21).

FIG. 17 shows one perspective of an embodiment of manipulator (48). Carriage (88) moves in a straight line along rack (89) under the action of motor (90). Said carriage holds a bracket (91) endowed with a rack (91a) which moves vertically under the action of motor (92); table (93) comprises a cut-out to allow the bracket-rack complex (91) full freedom of movement.

The clamp which grasps using its arms (48a) and (48b) is of the same type as the clamp shown in FIGS. 2 and 3.

Rod (58b) which ends with stop (58a) is fixed by bracket (58c) to table (93) positioned on the chassis of connection unit (32); said rod is held secure at a higher level than the clamps circulating on conveyor (1) in order to avoid any interference.

A preferential order of connection is one such that, when the ends are connected in a given order, the sections of wire corresponding to ends which are already plugged in and which are hanging do not cover the connector sockets remaining to be connected.

In a device according to the invention which connects the ends in a preferential order, it is advantageous to accentuate the downward curve which the wires naturally assume under the effects of their weight so that the connector sockets can be clearly disengaged, and a process according to the invention comprises means to fold the connected wires on the side opposite that of the sockets remaining to be connected. For example, when one end is plugged in, a manipulator slides, in a downward movement between the front surface of connector (39) and manipulator (48), a brush or part covered with a plastic element so as not to damage the wires, and moves away before returning upward.

FIG. 1 describes another advantageous embodiment to accentuate the curve; connector (39) is approached by clamp arms (48a), (48b) covered with a plastic element; this action can potentially be supplemented by a downward movement of said arm, which in this way fold the wires on the side opposite that of the sockets remaining to be connected, or downward, and disengage the connector sockets remaining to be connected, avoiding any mechanical interference.

FIG. 7 shows a sample preferential order of connecting two connectors (39) schematically depicted as connectors (55) and (56), knowing that the Z'Z axis is vertical and directed upward. The ends should be connected in the order defined by circuit B'B shown in FIG. 7 as a phantom line. The first end to be connected is thus (58a), and the last is (58t).

The preferential order which has been defined is not unique; more generally, the different levels must be filled individually in succession, preferably while making the connections in only one direction, i.e., in an order which does not require an end to be connected between two ends which have already been inserted at the same level.

For example, the bundle described in FIG. 8 comprises nine sections of wires which each connect a socket of connector (55) to a socket of connector (56), and, for example, according to an interconnection solution:

- The ends of section (57a): downstream connected to socket (55a) and upstream connected to socket (56i);
- The ends of section (57b): downstream connected to socket (55b) and upstream connected to socket (56h);
- The ends of section (57c): downstream connected to socket (55g) and upstream connected to socket (56g);
- The ends of section (57d): downstream connected to socket (55c) and upstream connected to socket (56c);
- The ends of section (57e): downstream connected to socket (55h) and upstream connected to socket (56f);
- The ends of section (57f): downstream connected to socket (55d) and upstream connected to socket (56b);
- The ends of section (57g): downstream connected to socket (55i) and upstream connected to socket (56e);
- The ends of section (57h): downstream connected to socket (55e) and upstream connected to socket (56a);
- The ends of section (57i): downstream connected to socket (55f) and upstream connected to socket (56d);

To connect connector (55) in a preferential order, for example, the downstream ends must be fed to the connection unit 32 in the following advantageous order of connection: (55a), (55b), (55c), (55d), (55e), (55j), (55i), (55h), and (55g).

The computer program predetermined by the operator orders the wires to be produced in the advantageous order in which the downstream ends must be placed on connector (55) according to the above advantageous connection order, i.e., (55a), (55b), 55c), (55d), (55e), (55j), (55i), (55h), and (55g) which will be the farthest

upstream on the conveyor, and the wire sections are cut and placed on the transfer in the following order: (57*a*), (57*b*), (57*d*), (57*f*), (57*h*), (57*i*), (57*g*), (57*e*), and (57*c*) which will be the farthest upstream.

The ends are fed in front of the interchange unit in the following order: (57*a*) downstream, (57*a*) upstream, (57*b*) downstream, (57*b*) upstream, (57*d*) downstream, (57*d*) upstream, (57*f*) downstream, (57*f*) upstream, (57*h*) downstream, (57*h*) upstream, (57*i*) downstream, (57*i*) upstream, (57*g*) downstream, (57*g*) upstream, (57*e*) downstream, (57*e*) upstream, (57*c*) farthest upstream.

This order is advantageous for connector (55), but is not optimum for connector (56), and to connect housing (56) in a preferential order, for example, the ends must be fed to the connection unit in the following advantageous connection order: (56*a*), (56*b*), (56*c*), (56*f*), (56*e*), (56*d*), (56*g*), (56*h*), and (56*i*) which amounts to feeding the upstream ends in the following order: (57*h*), (57*f*), (57*d*), (57*e*), (57*g*), (57*i*), (57*c*), (57*b*), and finally (57*a*), which will be the farthest upstream on the conveyor.

If the two connectors are held on the same component clamp 34*e*, the program predetermined by the operator can order the upstream ends to be connected to the connector to be interchanged two by two, producing the advantageous order wherein the upstream ends which go on connector (56) must be placed in the above advantageous connection order, without requiring that the set of ends which go on connector (55) be separated from those which go on housing (56) i.e.: (57*a*) downstream, (57*h*) upstream, (57*b*) downstream, (57*f*) upstream, (57*d*) downstream, (57*d*) upstream, (57*f*) downstream (57*e*) upstream, (57*h*) downstream, (57*g*) upstream, (57*i*) downstream, (57*i*) upstream, (57*g*) downstream, (57*c*) upstream, (57*e*) downstream, (57*b*) upstream, (57*c*) downstream, and finally (57*a*) upstream.

If the two connectors are held on two different component clamps, the program predetermined by the operator can advantageously order nine empty clamps to be placed on the conveyor upstream from the group of sections and to which the interchange unit will transfer the nine ends to be connected to connector (56) producing the advantageous order in which the upstream ends which go on connector (56) must be placed according to the above advantageous connection order, and the set of ends which go on connector (55) will thus be separated from those which go on connector (56), with the order after the interchange unit being as follows: downstream units to be connected to connector (56):

(57*a*), (57*b*), (57*d*), (57*f*), (57*h*), (57*i*), (57*g*), (57*e*), (57*c*), then all of the upstream ends to be connected to connector (56):

(57*h*), (57*f*), (57*d*), (57*e*), (57*g*), (57*i*), (57*c*), (57*b*), and finally (57*a*) which will be the farthest upstream on the conveyor.

It must be noted that said second solution can also be used if the two connectors are held in the same component clamp and in an advantageous variation of the process according to the invention, because the interchange time is generally faster, empty clamps are fed to said interchange unit, some of said ends are grasped and taken in other clamps holding ends, using the interchange unit, and said ends taken in some of said empty clamps are moved.

Another advantage of the invention is to allow the number of connectors which must be fed simultaneously on only one or several connection units to be limited, because this makes it possible to connect different connectors successively.

This advantageously reduces the number of connection units necessary and the number of connectors on the same component clamp, thus reducing the cost of the wiring machine and increasing its flexibility.

This also simplifies the connection units, which no longer have to manage the insertion order of the wires and thus in an advantageous process according to the invention, the connection unit is used to take some of said ends on said conveyor and arrange them in a predetermined manner in a connector, taking them in the same order as the order in which said ends are brought to said connection unit.

According to a preferred embodiment, a device according to the invention comprises a control mechanism which controls the operation of said interchange unit in order to rearrange the ends in a preferential order for said connection unit. The control device can advantageously be programmed and incorporated into computer (15).

FIGS. 9 and 10 show a preferred embodiment of the invention wherein the interchange unit advantageously rearranges all or part of the wire ends by arranging them in group or unit clamps, i.e., clamps which can grasp and hold several wires in a given order and in a limited space as shown in FIGS. 13 and 14.

Loading unit (5) and end processing units (20) are only shown in FIG. 10, while interchange unit (21) and two connection units are symbolized by (32) and (32'); it is advantageous to have several loading units on such a device to obtain a variety of wires.

There is a device (60*a*) at the upstream end of conveyor (1) and a similar device (60*b*) at the downstream end.

Parallel to conveyor (1) is a second accumulation conveyor (1') which can transfer the same clamps as the first, which is of the known friction belt type and which moves oppositely from the first so as to move the clamps from downstream to upstream. FIG. 11 provides a schematic view of one embodiment of two similar devices (60*a*) and (60*b*), only the location of which is shown schematically on FIG. 1, making it possible to transfer the clamps from one conveyor to the other.

FIG. 11 shows an embodiment of device (60*b*) composed primarily of a square cycle manipulator with two degrees of freedom endowed with a clamp (61) which grasps base (43*d*) at the foot (43*a*), a clamp (2X), which withdraws said clamp through a cut-out (42'') in the conveyor (1) in a movement along the X'X axis, which lowers it to the level of conveyor (1') to position (61*a*), which transports and positions the clamp on conveyor (1') through cut-out (42''') and returns empty to begin the same cycle again. This manipulator can be a commercially-available two-axis manipulator, or as shown in FIG. 11, a carriage (80) which moves along a rack (81) under the effect of motor (79) driving a pinion which meshes on said rack. Jack (82) which is being carried by and moves along with carriage (80) is advantageously electrical so that it can stop at different intermediary positions and satisfy all variations of neighboring devices of (60*b*). Clamp (61) is advantageously made in the same manner to be able to grasp the foot of an end clamp, a group clamp, or a component clamp, indiscriminately. Such a clamp (61) can be made by juxtaposing two clamps and by ordering the clamp corresponding to the position of the clamp foot to move.

FIG. 9 shows that return accumulation conveyor (1') also comprises a stop device (64) which holds all of the clamps stored on said conveyor and only allows them to

proceed one by one to stop (63) on command of computer (15). This stop moves along the X'X axis, and blocks the clamp at foot (42a). To allow only one clamp to proceed, the computer retracts said stop long enough to allow the foot of said clamp to proceed, and reengages said stop to block the foot of the following clamp. This stop can be made by a simple jack attached to the conveyer, and whose rod moves along the X'X axis to interfere with the foot of the clamp after it has come out and not to impede the movement of the clamp after it has moved back in.

According to the sample embodiment in FIG. 9 and FIG. 10, conveyors (65a) and (65b) are also endowed with a stop (64). As for conveyers (1') and (65a), the computer can, depending on a predetermined program, order a stop, for example, according to FIGS. 9 and 10, release a conveyor clamp (24) shown on conveyor (65a) of FIG. 9 to which reference was just made on a fixed stop (63), grasp said clamp (2Y) using clamp (61) of device (60a) and disengage it passing through all of the conveyors which comprise releases such as (42) on both surfaces along the X'X axis. Conveyor (65b) is not designed to store component clamps for loading device (60a) to position them on conveyor (1); there are no fixed stops (63) and said component clamps are driven by friction to the end of conveyor (65b) from which they fall freely into a collection box (69). An operator collects these empty component clamps, places them in the sockets of adapted components and then stacks them in loaders (40) or (40'').

According to another variation of a preferred embodiment, conveyor (65b) comprises stops and, like conveyor (65a), allows component clamps to be positioned on conveyor (1). Along the transfer path, said component clamp is fed to an automatic component loading unit in a component clamp made, for example, by combining a vibrating bowl and a manipulator of the known types, which automatically positions the components in the sockets of said component clamp. In said solution, the connection unit takes the component clamp on conveyor (1) instead of conveyor (33).

According to another variation which is a combination of the means of the two preceding embodiments, the components are positioned automatically by an automatic component positioning unit located on a conveyor which connects conveyor (65b) to conveyors (33). This new conveyor is endowed with loading devices of type (60a) which transfer component clamps to conveyors such as (33). FIGS. 9 and 10 show the sorting device (66) which is a subunit of device (60a) in which the vertical translation movement is eliminated. Stop (64a) can be retracted to allow the clamps which do not have to be transferred to one of conveyors (65a) or (65b) to continue on conveyor (1').

These FIGS. 9 and 10 show a device according to the invention which, under a preferred embodiment, comprises clamps of various types and having specific uses intended for the automatic connection of conductor wire or optical fiber section ends to connectors, which can be transported by the same conveyor on component clamps and can be separated from said conveyor, and which comprise all the same means to interface with said conveyor and an automatically-legible inscription allowing the type to be identified.

A remote reader (68), for example, a bar code-type device, is placed along conveyor (1'); said reader reads the type of clamp (2Z) stopped by stop (64b) and transmits a characteristic signal for this type to computer (15). Based on this signal or on this type information, the computer can order the stop (64b) to allow clamp (2Z) to abut against stop (63a) activated at that time, then to retract said stop if the clamp must be transferred to conveyor (1'), or to transfer this clamp using a clamp (61) to conveyors (65a) or (65b).

FIG. 9 shows conveyors (65a) (65b) which are the accumulation type and are endowed with a friction belt such as conveyor (1') and which return the clamps in the upstream direction of the wiring machine and store said clamps which device (66) has thus sorted.

FIGS. 4, 5, 6, and 13 show a sample embodiment of such an interface mechanism composed of a base (43d) endowed with a double rack of teeth (43b), a foot (43a) on which is inscribed a bar code (43c) representing at least the type of clamp and advantageously its individual number. According to a preferred embodiment, a device according to the invention advantageously comprises clamps of various types and having specific uses intended for the automatic connection of conductor wire or optical fiber section ends to connectors which can be transported on component clamps by the same conveyor and can be separated from said conveyor, and which can be mechanically engaged thereon or withdrawn therefrom, and which comprise all of the same means to interface with said conveyor and an automatically-legible inscription allowing the type to be identified.

Advantageously, a device according to the invention also comprises at least two different types of clamps and means to sort said clamps by type.

FIGS. 9 and 10 show a sample embodiment of interchange unit (21'). This unit is composed of a first subunit (21a) of the same type as interchange unit (21) and a subunit (21'b) which is of the same type as device (60b).

In this way, according to said figures, after having taken an empty clamp on conveyor (1), subunit (21'b) transfers the empty clamp to return conveyor (1') in the same way as device (60b). Conveyor (1') has a stop (64c) which is also controlled by computer (15) in order to prevent collisions on conveyor (1') between clamps transferring unit (21') and those already fed on the conveyor and transferred by other units or by device (60b).

According to a preferred embodiment shown on FIGS. 9 and 10, conveyor (1) is made by juxtaposition of two conveyors placed in succession (1a) and (1b) so that their synchronous belts allow the clamps to be transferred from one to the other. Each of said conveyors is endowed with its own motorization and can be moved independently of the other. Advantageously, the two conveyors (1a) and (1b) are juxtaposed opposite one of the last positions covered by the interchange unit and a clamp ejection device is associated with the downstream end of the first conveyor (1a). According to the non-restrictive example shown in FIGS. 9 and 10, this makes it possible, when a clamp has been ejected and according to an advantageous command mode, for computer (15) to move only conveyor (1a) to fill the empty place. In this way, there are no useless empty places on conveyor (1b) and interchange unit (21') can transfer a great number of ends into the same group clamp, regardless of the number of clamps covered by the movement of clamps such as clamp (22).

FIGS. 9 and 10 show a sample embodiment of connection units such as unit (32) shown in FIG. 1. Said unit is composed of a first subunit (32'a) which is of the same type as interchange unit (32) and a subunit (32'b) which is of the same type as device (60b).

In addition to device (60*b*), subunit (32'*b*) has the possibility of holding the clamp in the intermediary position shown in FIG. 10 as (53'I), which is an elevated position so that the wire or wires, if it is a group clamp, which it holds do not interfere with the clamps transported by conveyor (1). This function can be performed by a manipulator of the known type which moves the clamp under the control of computer (15) or else advantageously by a device such as the one in FIG. 11 with which the end or group clamp is transferred to and held in position (53'I) by moving carriage (80) to the upper end (81*a*) of the rack and by stopping electric jack (82) in an intermediary position.

In this way, according to the same figures, after having removed a clamp on conveyor (1) subunit (32'*b*) transfers and holds these clamp in the elevated position shown while subunit (32'*b*) takes the wire end held in the clamp. Subunit (32'*a*) then transfers the empty clamp conveyor (1') in the same way as device (60*b*). Conveyor (1') holds a stop (64*d*) which is also controlled by computer (15) so as to prevent collisions on conveyor (1) between clamps transferred by unit (32') with those already present on the conveyor and transferred by ther units or by device (60*b*).

Advantageously, in a process according to the invention, said connection unit and said conveyor are associated with means to withdraw at least one of said clamps from said conveyor and feed it to the connection unit. Advantageously, said clamp is recycled without being put back on said conveyor. In this way, while the connection unit connects the wire or wires present on the removed transfer clamp, the clamps immediately upstream from said removed clamp and which hold the ends which are not to be connected by said connection unit can continue.

According to another embodiment, subunit (32'*b*) does not feed the clamp in an intermediary position and its only function is to eject and recycle the clamp emptied of its wire. Advantageously, the clamps discharged of their ends by the connection unit ar withdrawn from said conveyor.

FIGS. 4, 5, and 6 show an embodiment of end clamps and their opening system (27). Such a clamp comprises two arms (73*a*), (73*b*) which hold the wire in collaboration with a piston (74*a*) inside a volume (83) formed by the intersection of the corresponding forms of said arms and piston. The arms close under the action of springs (73*f*), (73*e*) pivoting around axes (73*d*) and (73*c*); the piston is pushed upward by the action of spring (74*b*).

FIG. 5 shows a sample embodiment of the opening system (27) which comprises a part (77) which moves on axes (76) and is moved by jack (75). The end clamp comprises two lugs (78) attached to the arms. In the position shown in FIG. 5, the opening system does not act on the clamp. When jack (75) is activated, part (77) presses against lugs (78) and opens the arm.

FIGS. 9 and 10 also show the succession of operations performed to produce the bundle shown in FIG. 8, being manufactured using a continuous cycle.

Said FIGS. 9 and 10 show the first phase of production at the zone labelled (I), which runs from clamp (2*d'*) shown on conveyor (1) of FIG. 9 to group clamp (72*w*):

- clamps (72*v*), (72*w*) and eighteen end clamps (2*d'*) to (2*u'*).
- The conveyor transfers said clamps in front of different units (5), (4), and (20) which position or modify the ends.
- The end clamps hold the ends of the nine wires in the bundle positioned by the loading unit; said wires are regularly placed in pairs of consecutive clamps.
- The wires are arranged in the following order from upstream to downstream, which is the inverse of the optimum order used above, according to the needs of this particular embodiment: (57*a*), (57*b'*), (57*d*), (57*f*), (57*h*), (57*i*), (57*g*), (57*e*), and (57*c*) which will be the farthest downstream.

Said FIGS. 9 and 10 show the second phase of production at the zone labelled (II), which runs from group clamp (72*v*) to group clamp (72C):

- The group clamps are placed in the field of action of transfer clamps (22) and (23) (see FIG. 1) of interchange unit (21').
- The end clamp which is farthest downstream is empty and is being ejected by subunit (21'*a*) of said interchange unit to the return circuit where it will be sorted for reuse, so that another end clamp may be brought to the same position to continue to transfer ends into group clamps (72A) and (72B), while only moving transfer (1*a*), and thus without moving said group clamps.
- The nine upstream ends are all stacked in a set of zig-zagged rods of clamp (72B) and the order from top to bottom, i.e., the order in which the ends will be unstacked, is as follows: (57*h'*), (57*f'*), (57*d*), (57*e*), (57*g*), (57*i*), (57*c*), (57*b*), and finally (57*a*); this order is the preferential order of connection defined above.
- The nine upstream ends thus stacked in group clamp (72B) join the five downstream ends which have already been stacked in group clamp (72A) along strand (71*a*) and the four downstream ends still held individually in end clips, along four dispersed wires.
- Only five of the nine downstream ends are stacked in a set of zig-zagged rods of clamp (72A) in the following order from top to bottom: (57*h'*), (57*i'*), (57*g*), (57*e*), (57*c*). The four remaining ends will be taken and stacked, and by the interchange unit or transfer unit so that the order from top to bottom once the phase is terminated, i.e., the order in which the ends will be unstacked will be: (57*a*), (57*b*), (57*d*), (57*f*), (57*h'*), (57*i'*), (57*g*), (57*e*), (57*c*), this order being the above-defined preferred connection order.

The example was selected in order to explain a particular operation during the positioning of wires in the group clamps taking into account the limited length of the interchange unit and the field which its clamps cover.

In the example shown, the first end to be stacked in group clamp (72B) is the downstream end of wire (57*a*); said end is held in end clamp (2*e'*) which is farthest downstream, while the group clamp is farthest upstream and the distance between said clamps is nineteen steps; now, when group clamp 72B) is in the position shown in FIG. 9, the interchange unit reaches at most the level of clamp (72*v*), or a distance of thirteen steps.

A first solution is to limit production only to cases which the interchange unit can process directly, but it is advantageous for the interchange unit to transfer some wires temporarily to a standby position so that they can be taken later and arranged in a preferred order using this method; said advantageous embodiment makes it possible to expand the field of action of the device ac-

cording to the invention without increasing the zone covered by the interchange unit.

Group clamp (72B) is in accordance with the sample embodiment shown by FIGS. 13 and 14, which demonstrates that a group clamp comprises three sets of storage rods: (L), (M), and (N).

According to an advantageous process, when the interchange unit does not have access to an end which it must stack below an end held by an end clamp to be transferred to the ejection subunit (21'*a*), the computer orders the following operating sequence:

a. The interchange unit takes and stacks said end in rod set (N);

b. Operation (*a*) is repeated as many times as needed until the end to be stacked underneath reaches the field of the interchange unit, which takes it and positions it in rod set (L); the following sequence intervenes at this time:

c. If the highest of the ends stacked in rods (N) must come immediately above the last end stacked in rods (L), the interchange unit takes and transfers said end to rods (L) and the cycle continues to phase (*d*) below;

Otherwise, it transfers it into rods (L) and phase (*b*) resumes;

d. Computer 15 knows the preprogrammed transfer sequence, and if there is another critical end which satisfies phase (*c*), i.e., which must come immediately above the last end stacked in rods (L), the computer orders the interchange unit to resume cycle c, taking the ends in rod set (M) or (N) which holds said critical end, and no longer systematically in rod set (N);

Otherwise, the computer suspends the execution of this cycle and the interchange unit continues to stack the ends it grasps on the transfer, either until the turn of one of the ends stored in rods (M) or (N) comes, and in this case the computer orders that phase (*d*) be executed; or until the turn of an end which the interchange unit cannot grasp comes, and in this case the computer orders the interchange unit to transfer all of the ends on rods (M) to rods (N), then to execute phase (*a*).

According to another advantageous embodiment, rods (M) and (N) or a multiplicity of such rods do not have to be solidary with the group clamps.

The solution according to which said rods are solidary with the clamps is equally advantageous because the operating sequence described in the above process must be performed simultaneously as many times as there are clamps in the group to be processed simultaneously; the modularity of the group clamps and rods (B) and (C) correspond to the problem to be solved. FIGS. 9 and 10 show the third phase of production at the zone labelled (III), which runs from group clamp (72D) to and not including component clamp (34*e*):

Connection unit (40') is in the process of connecting, in preferential order, the downstream ends held in group clamp (72E) to connector (39') attached to component clamp (34'); the downstream ends remaining to be connected form the strand of wires (71*c*) between group clamps (72E) and (72F), and those already connected form strand (71*d*) between connector (39') and group clamp (72F);

After the last end is inserted, under the control of the computer, emptied group clamp (72E) is recycled and replaced by clamp (72D), the conveyor is advanced two steps (the computer orders the different other units to execute the actions corresponding to each step) and connection unit (40') places component clamp on the conveyor in the place left empty on the transfer;

Connection unit (40'') is in the process of connecting in preferential order the upstream ends held in group clamp (72G) to connector (39'') shown on conveyor 1 of FIG. 9 attached to component clamp (34'');

After the last end is inserted, group clamp (72G) shown in FIG. 9 is recycled and replaced by clamp (72D), connection unit (40'') places the component clamp on the conveyor in the place left open on the transfer.

These FIGS. 9 and 10 show the fourth phase of production at the zone labelled (IV), which runs from component clamp (34*e*) to the end of conveyor (1*b*):

When the bundle is completed, it must be removed before the empty clamps are recycled;

An operator intervenes in this zone to take the bundles. When a bundle is completed and transferred to the downstream end of conveyor (1), the computer suspends the operation of the wiring machine after having opened end clamps (3) located, if applicable, in said zone IV, through the use of opening mechanisms (27) which are individually associated therewith. After the operator has released all of the wires from the clamps, has removed all of the connectors from the component clamps holding them and thus has the completed bundle, he presses button (62) to tell the computer that his operation is completed. The computer then resumes sending production orders predetermined and programmed by the operator before the production cycle in progress begins.

In the embodiments of the invention described above, the ends fed to the interchange and connection units are each in a clamp. This presents a problem because the wire must be longer than the distance between two clamps and said distance is equal to the number of steps between the clamps.

To prevent this problem and expand the capacities of the wiring machine, some of said clamps make it possible to grasp and hold several wires in a given order and in a limited space.

FIGS. 13 and 14 represent one embodiment as a nonrestrictive example of such a clamp, comprising, like the other clamps, the same means to interface with said conveyor and an automatically-legible inscription making it possible to identify the type.

Said type of clamp has a plate (69) to which a plurality of rods (70) is attached. The rods are installed along axes such as L'L, M'M and N'N which themselves are parallel to the teeth in the same direction as lower surface (43*b*).

The distances between the axes of the rods placed on either side of axes L'L, M'M, and N'N is of the same magnitude as the diameter of one of the rods and is smaller than the length represented by this diameter plus the diameter of the smallest-diameter wire it must hold. The distance between the two right tangents closest to the two groups of rods is less than the length represented by the diameter of the smallest-diameter wire it must hold.

The wire which is deformed to circulate alternatively between rods (70*a*), (70*e*), (70*b*), (70*d*), and (70*c*) is held by deformation. Advantageously, the upper part of the rods is cut in an inward taper as shown in FIG. 13, so

that a stretched wire fed along an axis such as L'L is guided by said tapers to become engaged and to circulate alternatively between the rods arranged in a zig-zag.

Such a clamp is capable of holding wires of several diameters which must nonetheless remain within a few units of a diameter ratio for the flexible wires which are generally used, or within a smaller ratio if the wires are more rigid.

Several wires admitted in this manner can be stacked vertically in the same row arranged in a zig-zag such as (L), such as (M), or such as (N). These wires are kept in order because they cannot change levels, and a multiplicity of wires is held in a limited space.

Such a clamp of the type to grasp and hold several wire ends which comprises a group of rods arranged in a zig-zag to hold the wires is a preferred device according to the invention.

Nonetheless, it should be noted that the wires in the same row can be unstacked in the opposite order in which they were arranged.

Group clamps are more specially adapted to the transfer zone which begins at the interchange unit and extends to the connection units, and according to an advantageous embodiment, clamps of this type are introduced on the conveyor at the interchange unit and are withdrawn from said conveyor by the connection units.

Advantageously, the interchange unit transfers some of said ends to clamps making it possible to grasp and hold several wires in a given order and in a limited space.

The interchange unit in this case has the function of arranging the ends held two by two in two consecutive clamps of the type which makes it possible to grasp and hold several wires in a given order and in a limited space.

FIGS. 15 and 16 show a front view and a transverse section of an embodiment of a component clamp according to the invention. In addition to base (43*d*) and a foot (43*a*), this is composed of a flat rectangular panel or plate (84) comprising means to detachably fasten each connector in a specific position of said panel so that the adapted sockets of said connectors are perpendicular to said panel.

FIGS. 15 and 16 show a preferred embodiment in which the means to detachably attach the connectors to the panel are sockets (86) which pass through panel (84) and which are opened at their two ends.

FIGS. 15 and 16 show a preferred embodiment in which sockets (86) all are the same size, for example, a square whose side is greater than the largest dimension of the largest component. In this case, all of said clamps are identical and each connector is placed in an adaptor socket (85) which comprises standard means of attachment to said clamp and the specific means of attachment to said component.

The form detail (85*a*) of the adaptor socket is intended to absorb the thrust effort which exists upon connection, and which presses against the front surface of panel (84), i.e., the surface located on the side of connection manipulator (48).

The attachment mechanisms made according to the component and generally composed simply of a single elastic blade pressing against the connector are solidary with said adaptor socket which also comprises a cut-out adapted to the shape of the connector.

The adaptor socket preferably comprises a cut-out (85*a*) which issues on either side and a form detail (85*b*) which absorbs the stress of inserting the end into the component. In this way, the connector component clamps can not only be accessed from the side from which the ends are introduced into said clamps, but also from the opposite side of the clamps, which makes it possible to test said connections automatically.

Connectors (39) held on the same component clamp can advantageously be all component of the same branch of a bundle, and the adapted sockets can be of different types such as (87*a*) which is a blind female socket, (87*b*) which is a male socket, and (87*c*) which is a socket issuing from connector (39*c*).

FIGS. 18 and 19 show the interchange unit according to a partial perspective view of the invention.

FIG. 18 shows an embodiment of partial storage executed modularly using clamps (72) holding three sets of rods arranged in a zig-zag.

FIG. 19 shows an embodiment of partial storage executed in a fixed manner (89). Carriage (24) has means including jack (24') to move along the X'X axis allowing clamps (22) and (23) to transfer the wires into rod device (89), clamps (72) holding a set of rods arranged in a zig-zag.

What is claimed is:

1. A process for the automatic connection of ends of sections of conductor wire or optical fiber, to connectors, said process including the steps of:
- providing a conveyor having clamps which grasp and hold said ends;
- intermittently transferring said clamps with said ends along a given transfer path;
- selectively feeding some of said clamps with said ends to end processing units arranged laterally along said transfer path;
- selectively modifying said ends on said some of said clamps using said end processing units;
- feeding said clamps with said ends to an interchange unit which is placed laterally along said transfer path;
- modifying the order of some of said ends on said conveyor through the use of said interchange unit;
- feeding said clamps with said ends to at least one connection unit placed laterally along said transfer path downstream from said interchange unit;
- said connection unit comprising means for taking each of said ends and connecting it to each of said connectors;
- said connection unit selectively connecting said each of said ends to said each of said connectors in a predetermined manner;
- said ends being connected in an order which may be different from the order in which said ends are fed to said connection unit.

2. The process according to claim 1, further including steps of,
- feeding empty clamps to said interchange unit;
- said interchange unit moving said ends from said clamps with said ends to said empty clamps.

3. The process according to claim 1, wherein, said clamps are of different types.

4. The process according to claim 1, wherein, some of said clamps grasp and hold several wires in a given order and in a limited space.

5. The process according to claim 1, wherein, said clamps can be separated from said conveyor and can be

engaged mechanically thereon or withdrawn mechanically therefrom.

6. The process according to claim 4, wherein, said clamps which grasp and hold several wires in a given order and in a limited space are introduced on the conveyor at a level of said interchange unit.

7. The process according to claim 6, wherein clamps which grasp and hold several wires in a given order and a limited space are unloaded from said conveyor.

8. The process according to claim 6, wherein said interchange unit transfer some of said ends to clamps which grasp and hold several wires in a given order and in a limited space.

9. The process according to claim 1, further comprising, a control device which controls the operation of said interchange unit to rearrange said ends in a preferential order for said connection unit.

10. The process according to the claim 1, wherein the connection unit is used to take some of said ends on said conveyor, and said ends are arranged in a predetermined manner in said each of said connectors, and are taken in the same order as said ends are fed to said connection unit.

11. The process according to claim 1, wherein said connection unit and said conveyor are associated with means to withdraw at least one of said clamps from said conveyor and feed it to the connection unit.

12. The process according to claim 11, wherein said clamp is recycled without placing it back on said conveyor.

13. The process according to claim 1, wherein interconnection of several said connectors with conductor wire or optical fiber sections, includes use of several connection units arranged laterally along said transfer path.

14. The process according to claim 13, further comprising an overall control device which controls the operation of said several connection units so that said conveyor feeds an end to one of said several connection units in response to a first signal emitted by said overall control device and said one of said several connection units takes said end and connects it to one of said several said connectors in response to a second signal emitted by said overall control device, so that ends which do not correspond to said said one of said several said connection units skip said one of said several connection units.

* * * * *

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United States Patent [19]

Watanabe et al.

[11] Patent Number: 5,933,932

[45] Date of Patent: Aug. 10, 1999

[54] **APPARATUS FOR MAKING ELECTRICAL HARNESS**

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[73] Assignee: **Molex Incorporated**, Lisle, Ill.

[21] Appl. No.: **08/879,762**

[22] Filed: **Jun. 20, 1997**

[30] **Foreign Application Priority Data**

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[51] **Int. Cl.**[6] **B21B 15/00**

[52] **U.S. Cl.** ..... **29/33 M**; 29/564.6; 29/566.2; 29/749; 29/755

[58] **Field of Search** ..... 29/33 M, 566.1, 29/566.2, 566.3, 564.3, 857, 749, 751, 755, 564.4, 564.6

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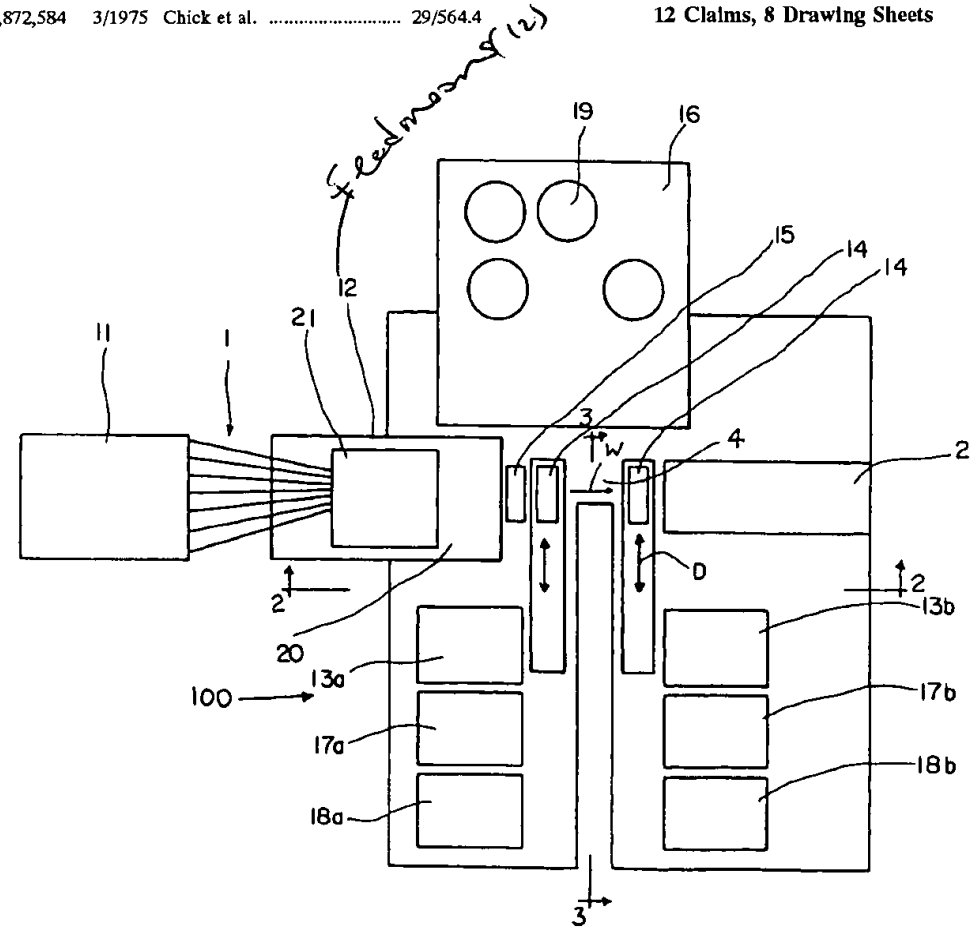
Primary Examiner—Daniel W. Howell
Assistant Examiner—Christopher Kirkman
Attorney, Agent, or Firm—Charles S. Cohen

[57] **ABSTRACT**

A wire harness-making apparatus includes a wire supply, a wire feeding unit for feeding and measuring harness wires from the wire supply, a wire transport unit for transporting the harness wires, and two connector crimping units positioned on the opposite sides of the harness wire set. The wire transport unit includes first and second wire clamps movable from opposite sides of the harness wires. The first and second wire clamps are driven along an associated top and bottom guides on opposite sides of the harness wire set. These clamps may he operated into and out of contact from vertical directions so as not to interfere with the feeding of wires by the wire feed unit.

12 Claims, 8 Drawing Sheets



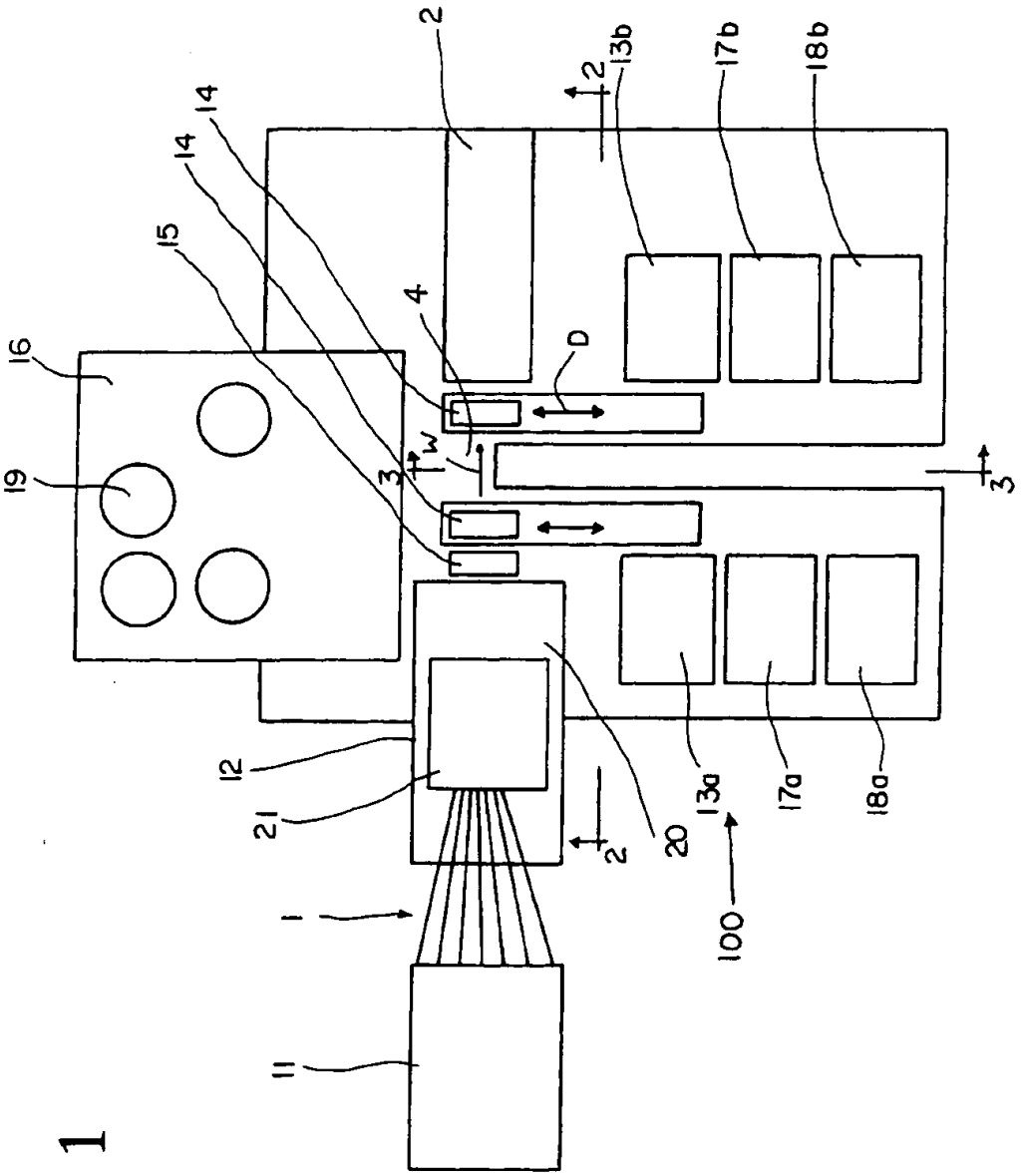
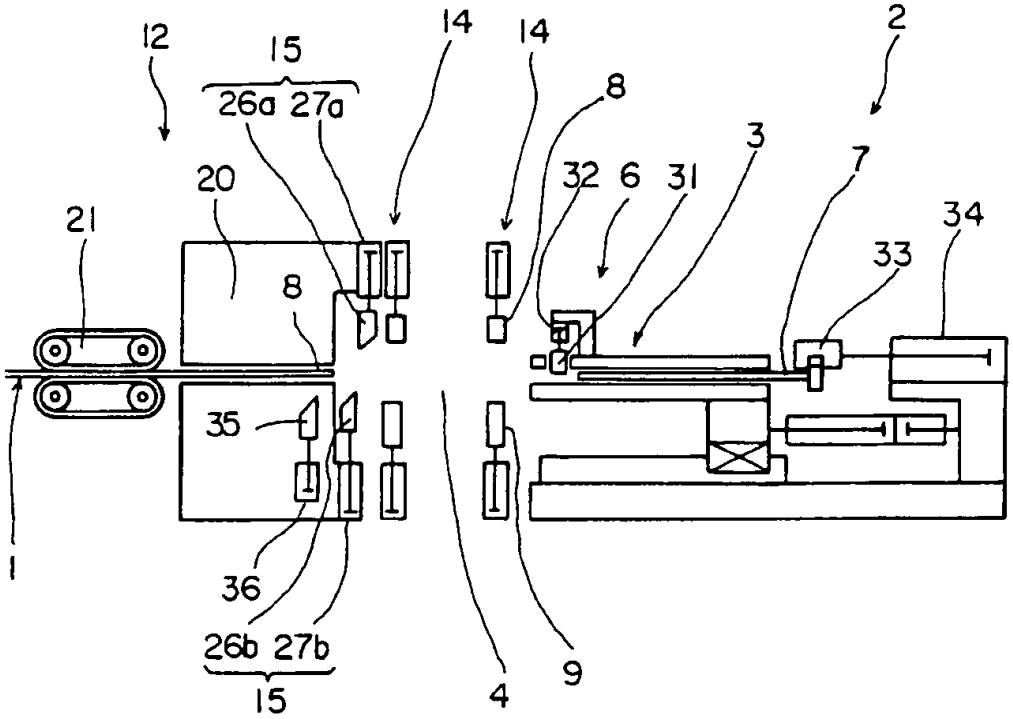


FIG. 1

FIG. 2



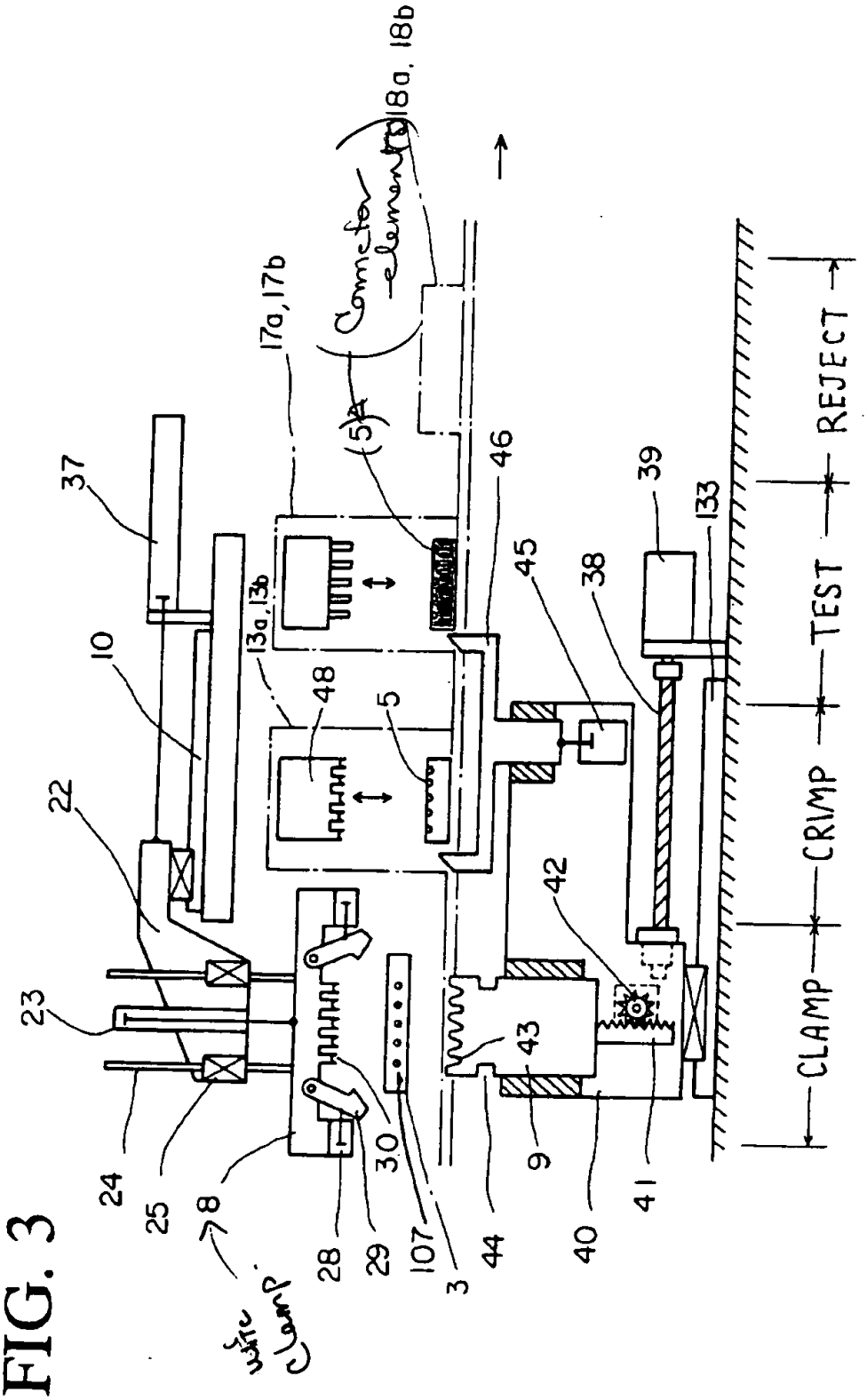

18a, 18b
Connector element
17a, 17b
(5)
46
37
39
133
REJECT
TEST
CRIMP
CLAMP
45
38
13a, 13b
10
48
5
22
42
23
43
24
25
78
30
9
41
28
29
107
3
44
40
Wire Clamp

FIG. 3

FIG. 4

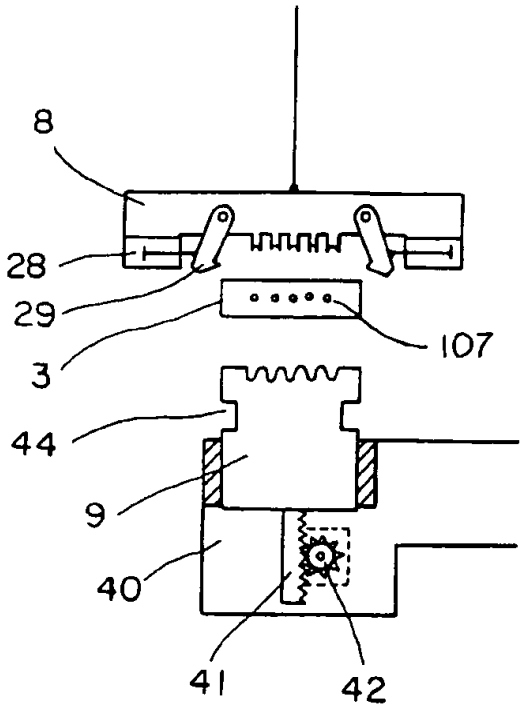


FIG. 5

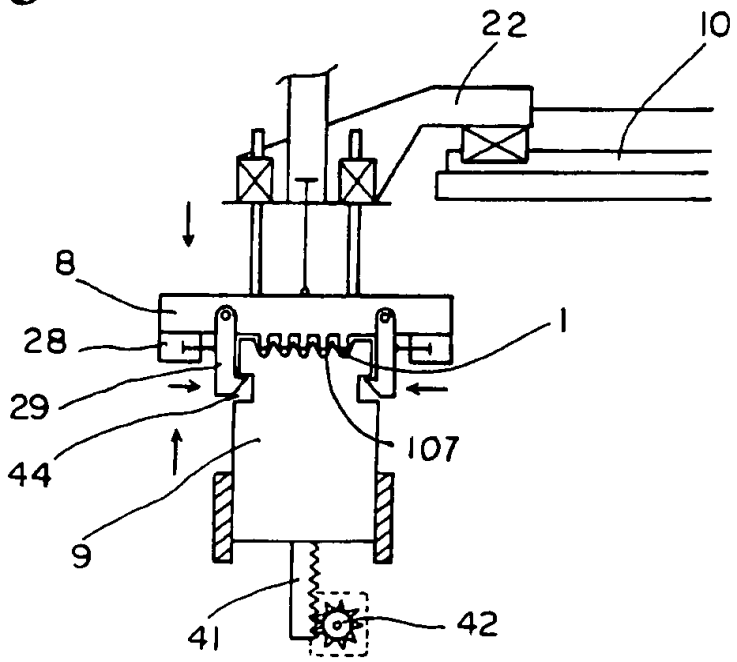
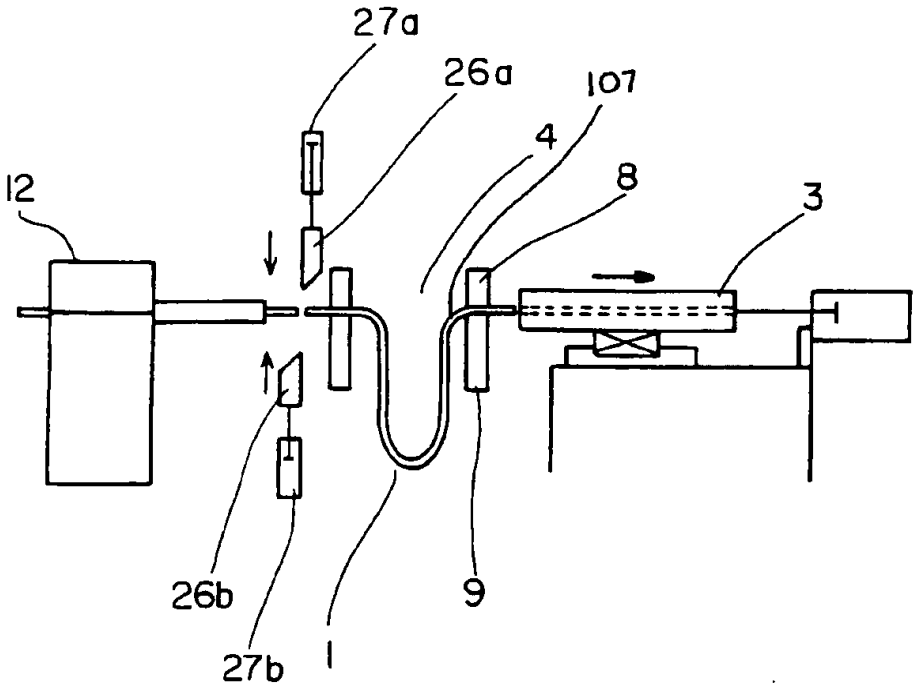


FIG. 6



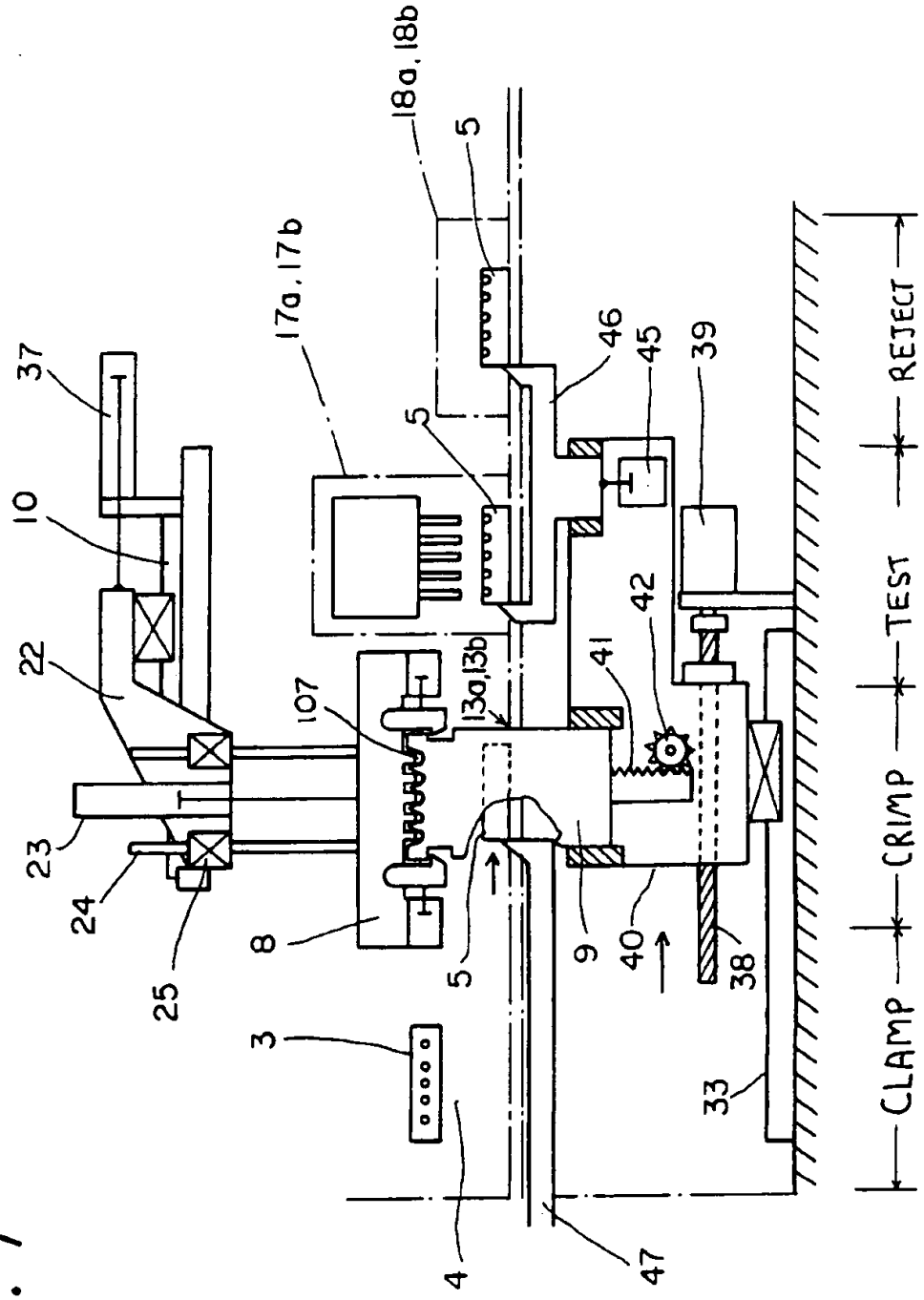

18a, 18b
5
17a, 17b
46
45
39
37
10
22
107
13a, 13b
41
42
23
24
25
8
3
5
9
40
38
33
4
47
REJECT
TEST
CRIMP
CLAMP

FIG. 7

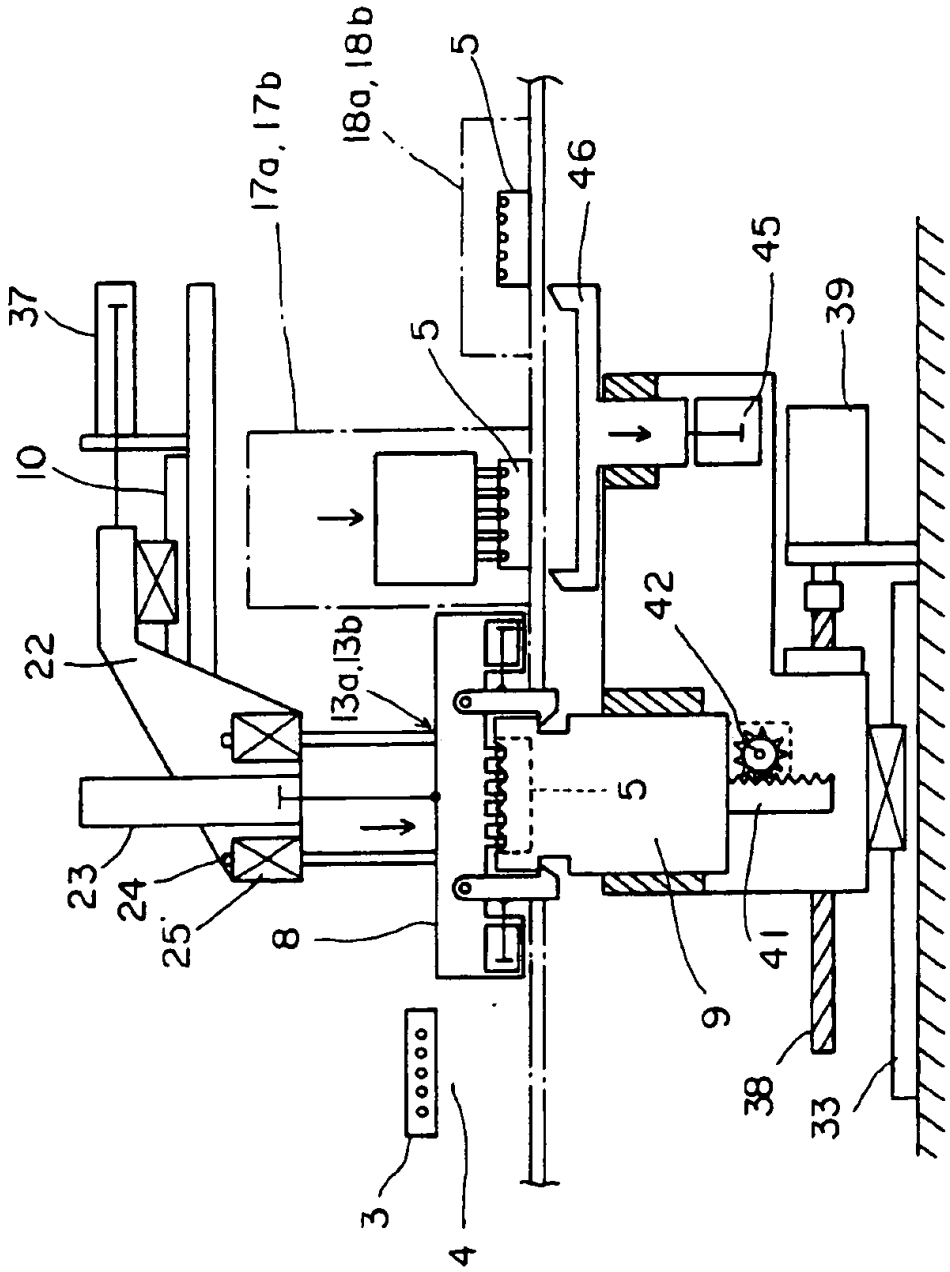


FIG. 8

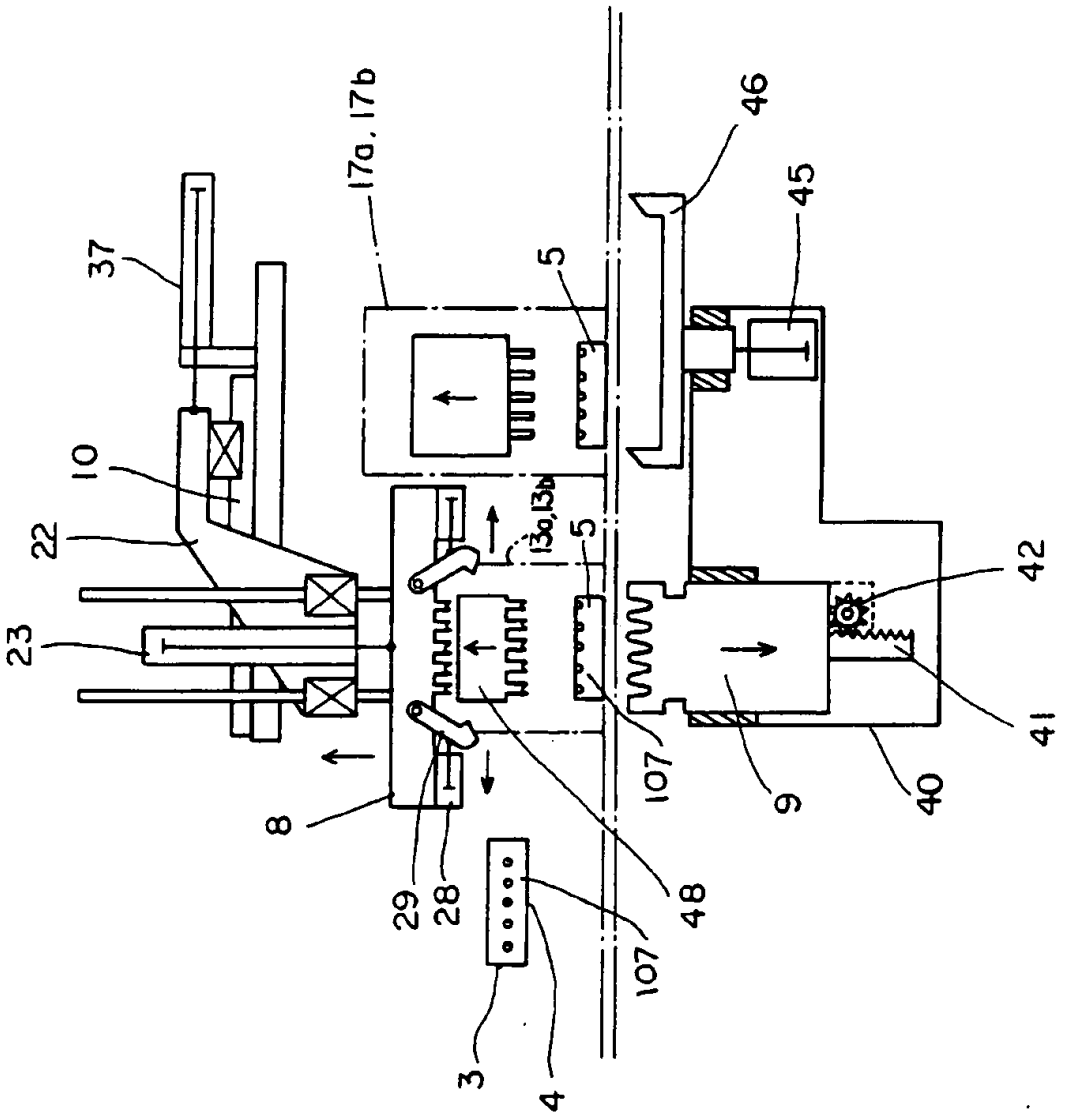


FIG. 9

APPARATUS FOR MAKING ELECTRICAL HARNESS

BACKGROUND OF THE INVENTION

The present invention relates to both methods of making wire harnesses and apparatus for making wire harnesses wherein the wire harness making apparatus includes an improved harness wire transport assembly.

Wire crimping apparatus have been used in the making of wire harnesses for some time. Such apparatus have been used to make wire harnesses that include a set of harness wires of a predetermined length and a set of electrical connectors connected to opposing free ends of the harness wires. A typical harness-making apparatus includes a wire supply, a wire measure and feed means for feeding a predetermined length of a set of harness wires from the wire supply, means for terminating connectors to the free ends of the wire harness set, means for cutting the harness wires to a specified length, and wire transporting means for holding the harness wires in place and transporting the harness wire set from the wire feeding means to the connector terminating means, downstream of the wire transporting means, whereat connector housings are terminated to the opposing free ends of the harness wire set, such as by crimping.

In such apparatus, the wire feeding means and the connector terminating means are arranged side-by-side transversely to the direction in which the wires are fed. Therefore, the wire transporting means is designed so to reciprocate between the wire feeding means and the connector terminating means transversely relative to the wire feed direction.

However, in the making of wire harnesses with such apparatus, the wire feeding means ceases operation for a time while the harness wire set is transported from its location immediately ahead of the wire feeding means to the connector terminating means, where connectors are terminated to opposing ends of the harness wire set. The wire feeding means lies dormant in a stand-by position until the connector termination has been completed. This dormancy is necessitated by the back and forth reciprocal movement of the wire transporting means across the feedpath of the wire feeding means, thus preventing the wire feeding means from operating during movement of the wire harness set to its termination location.

This dormancy is a disadvantage in the production of wire harnesses, because it lowers the efficiency with which harnesses can be made. There has been an increasing demand for the continuous working of wire feeding means because it takes relatively more time to feed and measure the harness wires in their discrete sets, as compared with the other wire harness assembly steps.

The present invention overcomes this disadvantage and virtually eliminates the dormancy of the wire feeding means by redirecting the movement of the harness wire set transporting means out of the feedpath of the wires.

SUMMARY OF THE INVENTION

Accordingly, it is a general object of the present invention to provide a method of making harnesses with an increased efficiency.

Another object of the present invention is to provide an improved wire transport means used in a wire harness-making apparatus for transporting a set of cut harness wires from a wire feed location to a connector termination location, the wire transport means having a movement that does not interfere with, or cross, the feedpath of the wire feeding means.

To attain these objects and advantages, a wire transport means is designed to cause no interference with the operation of the wire feed means and thereby permit the continuous operation of the wire feed means while connectors are connected to the opposite ends of the wires of the harness wire set. In this regard, the wire transport means engages a harness wire set from opposite sides of the wire set and thereupon moves the set of harness wires out of the wire feedpath of the wire feeding means. The wire transport means engages the harness wire set from opposite sides of the harness wires and in doing, avoids interference with the wire feedpath of the wire feeding means.

The invention includes a method of making harnesses utilizing the sets of feeding a set of harness wires from a wire supply and measuring each of the fed wires to achieve a predetermined length of harness wires, cutting the harness wire set to form a discrete set of harness wires; gripping the harness wire set and transporting the harness wire set from the wire feedpath, along a wire harness assembly path to a connector terminating means and applying connectors to opposing ends of the harness wire set, and while the connectors are being connected to the opposing ends of the harness wire sets, the wire feed means is effecting another subsequent feeding and measuring of a harness wire set.

An improved wire harness-making apparatus a plurality of wire reels in accordance with the inventor includes: a wire feed means for feeding wires from a wire supply and measuring the wires as they are fed therefrom, a wire transport means for transporting the set of harness wires after their feeding; and, connector terminating means positioned on the opposite sides of the wire harness assembly path for terminating connectors to opposing ends of the harness wire sets.

In one aspect of the present invention, the wire transporting means includes a first wire clamp movable above the harness wires fed from the wire feeding means and a second wire clamp movable below the harness wires. In the preferred embodiment, the first clamp is operatively connected to a moveable head and driven along an associated upper guide rail perpendicular to the wire feedpath and the second wire clamp is operatively connected to a movable base driven along an associated lower guide rail extending perpendicular to the wire feed path. The first and second clamps are aligned together and move in unison with each other to transport serial harness wire sets from the wire feeding means to the connector terminating means. The first and second clamps are capable of spreading apart from each other to return from the connector to the wire harness-making feeding means.

In another aspect of the invention, the wire apparatus further comprises means to separate the first and second wire clamps form a coupled in the engagement condition in which these parts are put on each other to hold the electric wires therebetween.

These and other objects, features and advantages of the present invention will be clearly understood through consideration of the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

In the course of the following detailed description reference will be frequently made to the accompanying drawings in which:

FIG. 1 is a plan view of a wire harness-making apparatus constructed in accordance with the principles of the present invention;

FIG. 2 is a frontal elevational view of the wire harness-making apparatus of FIG. 1 taken along lines 2—2 thereof;

FIG. 3 is an elevational view of the wire transporting means of the wire harness-making apparatus of FIG. 1 taken along lines 3—3 thereof;

FIG. 4 is a detail end view illustrating the wire transporting means in a ready condition as it awaits for completion of the feeding of a set of harness wires;

FIG. 5 is a detailed view of the harness-making apparatus illustrating the wire transporting means in a coupled condition wherein it holds the harness wire set in place for transport;

FIG. 6 is an abbreviated frontal view illustrating how the harness wire set is cut while held by the wire transporting means;

FIG. 7 is the same elevational view as FIG. 3, but illustrating how the harness wire set is moved to the connector by the wire transporting means;

FIG. 8 is the same view as FIG. 8 illustrating how the electric connectors are terminated to opposite ends of the harness wire set held by the wire transporting means; and,

FIG. 9 is the same view as FIG. 8, but illustrating how the wire terminating means works after having connected the electric connector housings to the wires held by the wire holding-and-transporting unit.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a wire harness making apparatus constructed in accordance with the present invention is shown generally at **100** and includes a wire supply in the form of a plurality of wire reels **11**, each such supply reel having a supply of wire **1** wound therearound, a wire feeding means **12** for feeding wires **1** from the wire supply reels **11**. As the wire feeding means feeds the wires, it also measures the length of the wire fed out through the feeding means for selected predetermined lengths. A wire pulling means **2** is positioned forward of the wire feeding means **12** to assist in the wire feed process and is spaced apart from the wire feeding means **12** to define a wire feed space, or opening **4**, therebetween.

Depending on the length desired for the wire harness, the wires may or may not be "looped" into the wire feed space **4** as is known in the art and as shown in FIG. **6**. The wire feeding means **12** may include, as shown in FIG. **2**, a feed belt conveyor **21** driven by a servomotor in order to measure the length of electric wires **1** fed. A wire-to-wire interval setting mechanism **20** is also provided and preferably includes a wire pitch changer **35** driven by an associated drive assembly, illustrated as a piston-and-cylinder drive **36** as shown. The wire pitch changer **35** is preferably selectively utilized to change the wire-to-wire spacing, or "pitch", between adjacent wires in order to match the pitch on the connector elements **5** applied to the harness wires.

The wire pulling means **2** may also include a movable guide member **3** which may be moved toward and away from the wire feeding means **12** and an engagement member **31** fixed to the guide member **3**, near the front thereof. The engagement member **31** is driven by a drive assembly, such as the piston-and-cylinder drive assembly **32** illustrated. The guide member **3** may includes a means for stopping **6** the wires in a specific alignment, utilizing pins **7** thereon that engage one set of the free ends of the harness wire sets prior to cutting. Such alignment pins are driven in their operation by an associated piston-and-cylinder drive assembly **34**.

The wire harness apparatus further comprises a wire transport means **14** for transporting each harness wire set after a predetermined length thereof has been fed from the wire feeding means **12** to a connector terminating means **13***a*, **13***b*. The connector terminating means **13***a*, **13***b* is provided for terminating connector elements **5** to opposing free ends of the harness wire sets. In order to provide a continuous supply of connector elements **5** to the connector terminating means **13***a*, **13***b*, a connector element storage area **16** is provided with a part feeder **19** and positioned alongside the wire feed space **4** so that it may feed connector elements **5** to the connector terminating means **13***a* and **13***b*.

The connector terminating means **13***a*, **13***b* are positioned on the other, opposite side of the wire feed space **4** with respect to the connector housing storage **16**. The wire transport means **14** holds a set of harness wires of predetermined lengths near their opposing free ends and moves them along an assembly path indicated by the arrow D in FIG. **1** in order to transport, or transfer, them downstream from the wire feed space **4** to an intervening space **102** between the right and left connector terminating means **13***a* and **13***b*. A wire harness testing means **17***a*, **17***b* and a wire harness rejection means **18***a*, **18***b* are positioned in serial order downstream of the connector terminating means **13***a*, **13***b*. These various means are located along a wire harness assembly path D, that as explained below, runs transversely, or perpendicularly to the wire feed path W of the wire feeding means **12**.

A wire cutting means **15** is best illustrated in FIG. **2** and is disposed in the feed path of the harness wires **1**. This cutting means is provided to cut the wires fed by the wire feeding means **12** in order to define, in serial order, discrete sets of harness wires. The cutting means **15** includes a first cutting blade **26***a* driven by an associated piston-and-cylinder drive assembly **27***a* and a second cutting blade **26***b* driven by an associated piston-and-cylinder drive assembly **27***b*. The cutting means **15** is preferably positioned on the upstream side of the wire feed path W (FIGS. 1 & 2) so as not to interfere with the wire transport means **14**.

One essential aspect of the wire harness-making apparatus of the present invention resides in the structure and operation of the wire transport means **14**. As shown in FIG. **3**, the wire transport means includes a first wire clamp **8** disposed above the level of the get of harness wires **1** and a second wire clamp **9** disposed below the harness wire set **1**. These first and second clamps are operable between ready positions (shown to the left of FIG. **3**) and terminating positions (shown to the Left in FIGS. **7** & **8**). As can be seen, the first and second clamps **8**, **9** lie on opposite sides of the harness wire set.

The first clamp **8** is driven on movable head **22** by an associated piston-and-cylinder drive assembly **37** along an upper guide rail **10** that extends at an angle to the feed path W along which the harness wires are fed by the wire feeding means **12**. Preferably, the first and second clamps are oriented perpendicular to the feed path W. The first wire clamp **8** is further movably mounted to the head **22** by an additional drive assembly, such as a piston-and-cylinder drive assembly **23**, so that the first wire clamp **8** may be driven in another direction during operation of the apparatus **100**. This direction of operations vertical and the first clamp **8** reciprocates toward and away from the harness wire set. In this regard, the head **22** may include linear guides **25** that will permit the controlled vertical movement of the first wire clamp **8**.

A movable base **40** is provided beneath the level of the harness wire set and may be driven in a reciprocating fashion like the head **22** by an associated linear drive means, such as

the drive screw **38** and a servomotor **39** illustrated in FIG. **3**. The base **40** is moved along an associated lower guide rail **133** that extends perpendicular to the wire feeding direction W, but along the wire harness assembly path D to move the second wire clamp **9** in its movement. The second wire clamp **9** is also capable of vertical movement so that it may be selectively moved into and out of contact with the harness wire set disposed thereabove. This reciprocating movement is accomplished by a drive means, such as the associated rack **41** and pinion gear **42** illustrated in FIG. **3**.

The first wire clamp **8** is preferably equipped with latches **29**, which are actuated between opened and closed positions by an associated piston-and-cylinder drive assembly **28**. The first wire clamp **8** has a series of wire-clamping teeth **30** formed between the latches **29**. The second wire clamp **9** has grooves **43** formed on its upper surface, so that the wire engagement teeth **30** of the first clamp **8** may be aligned with and in the grooves **43** of the second wire clamp **9** when the two clamps **8** and **9** mate together. In order to effectuate proper coupling of the first and second wire clamps **8,9**, the second clamp **9** preferably includes a pair of slots **44** formed on its opposite sides so that the latches **29** of the first wire clamp **8** will catch the opposing slots **44** of the wire clamp **9** when the two wire clamps **8** and **9** mate together. This coupling holds the harness wires in place as a set while they are transported from the wire feed path W to the connector terminating means **13***a*, **13***b*.

The lower base **40** of the wire transport means **40** includes a connector element advancement means in the form of a harness shuttle **46** mounted toward in its right end. (FIG. **7**) This harness shuttle **46** may be lowered and raised by an associated piston-and-cylinder drive assembly **45**. When the base **40** moves, connector elements **5** that have been previously advanced to the connector terminating means **13***a*, **13***b* are likewise moved from the connector housing terminating means **13***a* and **13***b* to the wire harness testing means **17***a*and **17***b*. Simultaneously, tested connector elements at the testing means **17***a*, **17***b* are then shifted as shown in FIG. **7** from the testing means **17***a*, **17***b* to the harness rejection verification means **18***a* and **18***b*.

Referring now to FIG. **4** and subsequent drawings, the method of making harnesses utilizing the wire harness making apparatus of the present invention shall be described. First, the first and second wire clamps **8**, **9** are placed into a "ready" or "stand-by" position where they are moved away from the wire feed path W. In this regard, the first wire clamp **8** is raised and the second wire clamp **9** is lowered (FIG. **4**.) as the two clamps **8**, **9** await the arrival of a set of harness wires fed from the wire feeding means **12**. At this time, the wire feeding means **12** draws wires **1** off of the wire supply reels **11** in conjunction with the wire pulling means **2** to feed a predetermined length of wire into the wire feed space **4** to define a set of harness wires.

After the wires **1** are fed along the wire feed path W to form a set of harness wires, the first wire clamp **8** is lowered by its drive assembly **23** and the second wire clamp **9** is raised by movement of its pinion gear **42**. In this manner, the harness wire set **107** is thereby held between the teeth **30** of the first wire clamp **8** and the grooves **43** of the second wire clamp **9**. Then the clamps **8** and **9** are coupled by closing them and engaging the latches **29** of the first wire clamp **8** with the opposing slots **44** of the second wire clamp **9**, as shown in FIG. **5**.

After the harness wire set is held by the two clamps **8**, **9**, the wires thereof are cut near the wire feeding means **12** by the cutting blades **26***a* and **26***b*, as seen in FIG. **6** to define a set of trailing free ends of the wire set. At the same time, the leading free ends of the electric wires **1** are released from the wire pulling means **2** so that a single set of harness wires are formed that is held by the wire transport means **14**.

Next, the wire transport means **14** is activated and the linear drive, i.e., the drive screw **38** and servomotor **39** are actuated to carry the coupled first and second clamps **8** and **9** that hold the wire set **1** therebetween to the connector terminating means **13***a* and **13***b*, as shown in FIG. **7**. The connector elements **5** of the preceding wire harness set in place at the connector terminating means **13***a* and **13***b* are then shifted in serial order to the harness testing means **17***a* and **17***b* by the harness shuttle **46** and the connector elements **5** previously at the testing means **17***a* and **17***b* are likewise shifted to the harness rejection means **18***a* and **18***b* by the harness shuttle **46**. In synchronization with this shifting, new connector elements are fed from their storage area **16** to the connector terminating means **13***a* and **13***b* by the connector loader **47**. Because the wire feed space **4** is not yet occupied by any harness wires **1**, the feeding of harness wires **1** occurs concurrently with the shifting of the harness wire set to the connector terminating means **13***a* and **13***b* by the first and second wire clamps **8**, **9** of the wire transport means **14**.

While a subsequent feeding of a harness wire set is being effected, the harness wires **1** previously shifted to the connector terminating means **13***a* and **13***b* are thereupon terminated to the connector elements **5**, such as by crimping, to form a completed wire harness. The completed harnesses pass, in serial order, downstream along the harness assembly path, through the harness testing means **17***a* and **17***b* and the rejection means **18***a* and **18***b*, where defective harnesses, if any, are identified and rejected. Referring to FIG. **9**, connector elements **5** are connected to the harness wires **1** in the embodiment illustrated by lowering termination members, illustrated in the preferred embodiment as a crimper **48** having wire-contacting teeth, provided in each of the connector terminating means **13***a* and **13***b*. The contact made by the crimpers **48** terminates the harness wires **1** to the connector elements **5** in a conventional manner, such as by insulation displacement.

In terminating, the pinion gear **42** is rotated in synchronization with the descent of the crimper **48** so that the wire clamps **8** and **9** are slightly lowered. This synchronization has the effect of preventing the harness wires **1** from bending at their transition portions which occur between the crimping teeth **48** and the engagement portions of the wire clamps **8**, **9**. Also, the lengths of the harness wires **1** that extend from the wire clamps **8**, **9** to their free ends which are connected to the connector elements **5** may be reduced to minimum as required, preventing irregularity in the wire ends or nonlinearity in the wire lengths. Thus, the terminal pieces can be crimped to the wire ends in good condition.

Subsequent to the termination of the harness wires **1** to the connector elements **5**, the piston-and cylinder **28** is operated so that the latches **29** of the clamp **8** are opened and disengage with the oppossing slots **44** of the second wire clamp **9**, thus uncoupling the first and second wire clamps **8**, **9**. Then their respective drive assemblies are operated so that the first wire clamp **8** is raised and the second wire clamp **9** is lowered, to thereby release the completed wire harness from the wire transport means **14**. The crimper **48** is also raised up to a stand-by position.

At the time of this release, a set of harness wires **1** from the wire feeding means **12** appear at the wire feed space **4**. Therefore, the drive assemblies are operated so that the first and second wire clamps **8**, **9** are shifted to the wire feed

space 4 in unison. Then the same proceeding as described above is repeated to produce an additional wire harness.

As may be understood from the above, in making harnesses according to the present invention harness wires are terminated to connector elements, and subsequent sets of harness wires are measured and fed concurrently. The present invention does not require that the wire feeding means be taken out of operation and put in a dormancy, or stand-by position. Accordingly, wire harnesses can be made at an increased efficiency.

In a wire harness-making apparatus according to the present invention, the wire transport means is so constructed as to cause no interference with the wire feed path W or wire feed space, and therefore, subsequent feeding of harness wires can be started concurrently with the shifting of harness wires from the wire feed space to the connector terminating means. Accordingly, harnesses can be made at an increased efficiency.

While the preferred embodiment of the invention have been shown and described, it will be apparent to those skilled in the art that changes and modifications may be made therein without departing from the spirit of the invention, the scope of which is defined by the appended claims.

We claim:

1. An apparatus for making wire harnesses, each of the wire harnesses having a set of wires extending between two connector elements, the apparatus comprising: a wire supply, means for feeding preselected lengths of wire from said wire supply along a wire feed path of said apparatus, a harness assembly path extending at an angle to said wire feed path, means for cutting said lengths of wire to define a set of harness wires having free wire ends on opposite ends of the harness wire set, means for terminating connector elements to said harness wire set free ends, and means for transporting said harness wire set from said wire feed means to said terminating means, said wire transport means including first and second wire clamps disposed on opposite sides of said harness wire set for clamping said harness wire set near said opposite ends thereof, said first and second wire clamps being capable of first movements in which said first and second wire clamps reciprocate along said harness assembly path between said wire feed means and said terminating means, said first and second wire clamps being further movable in second movements in which said first and second wire clamps move into and out of clamping engagement with said harness wire set from opposite sides of said harness wire set, said first and second wire clamp first and second movements being synchronized such that said first and second wire clamps do not interferingly move into said wire feed path of said wire feed means during feeding thereby of said harness wire sets, said apparatus further including means for coupling said first and second wire clamps together after they have contacted said harness wire set and for maintaining said first and second wire clamps coupled together as said wire transport means transports said harness wire set from said wire feed means to said terminating means, said first and second wire clamp coupling means including at least one engagement member disposed on one of said first and second wire clamps that engages the other of said first and second wire clamps.

2. The wire harness apparatus of claim 1, wherein said first and second wire clamps are disposed near said opposite free ends and first wire clamps are further disposed above said harness wire set and said second wire clamps are disposed beneath said harness wire set, each of said first wire clamps being aligned with a corresponding second wire clamp.

3. The wire harness apparatus of claims 2, wherein said first and second wire clamps are driven in said first and second movements by respective first and second drive assemblies that selectively reciprocatingly drive said first and second wire clamps between said wire feed means and said terminating means.

4. The wire harness apparatus of claim 3, wherein said first drive assembly includes a guide rail extending between said wire feed path and said terminating means and, a drive head movably mounted thereon, said first wire clamp being operatively connected to said drive head, said first wire clamp being further operatively connected to a first clamp actuating drive assembly that selectively moves said first wire clamp into and out of contact with said harness wire set.

5. The wire harness apparatus of claim 4, wherein said second drive assembly extends between said wire feed path and said terminating means and includes, a drive base mounted thereon, said second wire clamp being operatively connected to said drive base and movable thereon, said second wire clamp being further operatively connected to a second wire clamp actuating assembly that selectively moves said second wire clamp into and out of contact with said harness wire set, and further including means for synchronizing movement of said first and second drive assemblies such that they move in unison in their first movements between said wire feed means and said terminating means.

6. The wire harness apparatus of claim 5, wherein said first and second wire clamp actuating assemblies respectively move said first and second wire clamps in opposing vertical movement.

7. The wire harness apparatus of claim 1, wherein said first and second wire clamp coupling means engagement member includes at least one latch disposed on one of said first and second wire clamps, and a slot disposed on the other of said first and second wire clamps, said latch engaging said slot to maintain first and second wire clamps in a coupled condition.

8. The wire harness apparatus of claim 1, wherein said wire clamping means first and second movements are operatively synchronized together such that when said wire transport means is moving toward said wire feed means, said wire clamping means is moved out of contact with said harness wire set and when said wire transport means is moving from said wire feed means toward said terminating means, said wire clamping means is moved into contact with said harness wire set.

9. An apparatus for making wire harnesses, the apparatus comprising: a supply of multiple wires; means for feeding and measuring preselected lengths of wire from said wire supply, said wire feeding means feeding said wire lengths along a wire feed path, each of said wires being separated by a preselected wire-to-wire spacing; means for cutting said wires fed from said wire feeding means to define a set of harness wires having two sets of free ends on opposite ends of said harness wire set; means for terminating said connector elements to said harness wire set free ends, means for transferring said harness wire set along a wire harness assembly path from said wire feeding means to said terminating means, the wire transfer means including a wire clamping mechanism having first and second wire claps disposed on opposite sides of said harness wire set for contacting said harness wire set and maintaining said wire-to-wire spacing of said harness wire set, said wire transfer means including first and second drive means for respectively driving said first and second wire clamps in reciprocating horizontal movement between said wire feeding

means and said terminating means, the wire first and second wire clamps being movable in a reciprocating horizontal movement along said wire harness assembly path between said wire feeding means and said terminating means, said first and second wire clamps being further movable in a reciprocating vertical movement in and out of contact with said harness wire set to clamp said harness wire set during movement thereof from said wire feeding means to said terminating means, said wire transfer means including means for coupling said first and second wire clamps together as said wire transfer means moves between said wire feeding means and said terminating means, said wire clamp coupling means including at least one latch disposed on one of said first and second wire clamps and a slot disposed on the other of said first and second wire clamps, said latch engaging said slot to maintain said first and second wire clamps in a coupled condition.

10. The wire harness assembly apparatus of claim **9**, wherein said first and second drive assemblies are vertically aligned together along said harness assembly path.

11. The wire harness assembly apparatus of claim **10**, wherein said first and second wire clamps are vertically aligned with each other.

12. The wire harness assembly apparatus of claim **10**, wherein said wire clamp coupling means includes a pair of latches disposed on opposite sides of one of said first and second wire clamps and a pair of slots disposed on opposite sides of the other of said first and second wire clamps, said latches engaging said slots to maintain said first and second wire clamps in a coupled condition.

* * * * *

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United States Patent [19]

Igura

[11] Patent Number: 5,477,606

[45] Date f Patent: Dec. 26, 1995

[54] **ASSEMBLY GUIDING APPARATUS FOR WIRING HARNESS SUBASSEMBLIES**

[75] Inventor: **Toshinori Igura**, Shizuoka, Japan

[73] Assignee: **Yazaki Corporation**, Tokyo, Japan

[21] Appl. No.: **354,230**

[22] Filed: **Dec. 12, 1994**

[30] **Foreign Application Priority Data**

Dec. 14, 1993 [JP] Japan 5-313036

[51] **Int. Cl.**[6] **B23Q 15/00**; H01R 43/20

[52] **U.S. Cl.** **29/721**; 29/748

[58] **Field of Search** ..... 29/717, 718, 720, 29/721, 747, 748, 750, 752, 759, 33 M, 703; 269/903

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Primary Examiner—Peter Vo

Attorney, Agent, or Firm—Armstrong, Westerman, Hattori, McLeland & Naughton

[57] **ABSTRACT**

The assembly guiding apparatus for wiring harness subassemblies facilitates assembly work by indicating the connector to be used and displaying the terminal insertion position in the connector. The apparatus comprises: a plurality of connector boxes **3** containing connectors, each of which is provided with an indicator lamp **4** and a light interception sensor **5** facing a connector pick-up opening **14**; an incrementing sensor **8** installed on the pick-up side of terminated wires **7** that are arranged in line on a wire supporting device **6**; an indicator **10** that indicates with light a contour of the connector **2** and positions of terminal accommodating chambers in the connector **2**; and a controller **13** incorporating a CPU and a memory, both connected to the indicator lamp, the light interception sensor, the incrementing sensor and the indicator. The apparatus also includes: a count means linked to the incrementing sensor to detect the number of remaining terminal accommodating chambers in the connector, or the sum of the number of all terminals in the wiring harness subassembly and the number of all connectors; a count means that is activated when the number of remaining terminal accommodating chambers is one; and a reset means which is activated when the total sum is counted up.

5 Claims, 3 Drawing Sheets

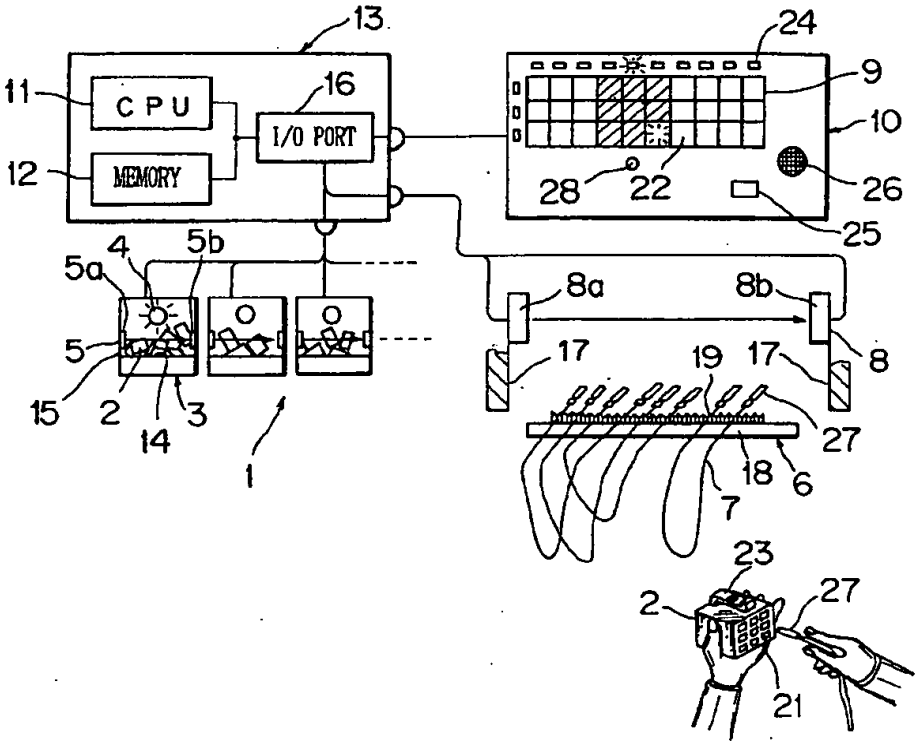


FIG. 1

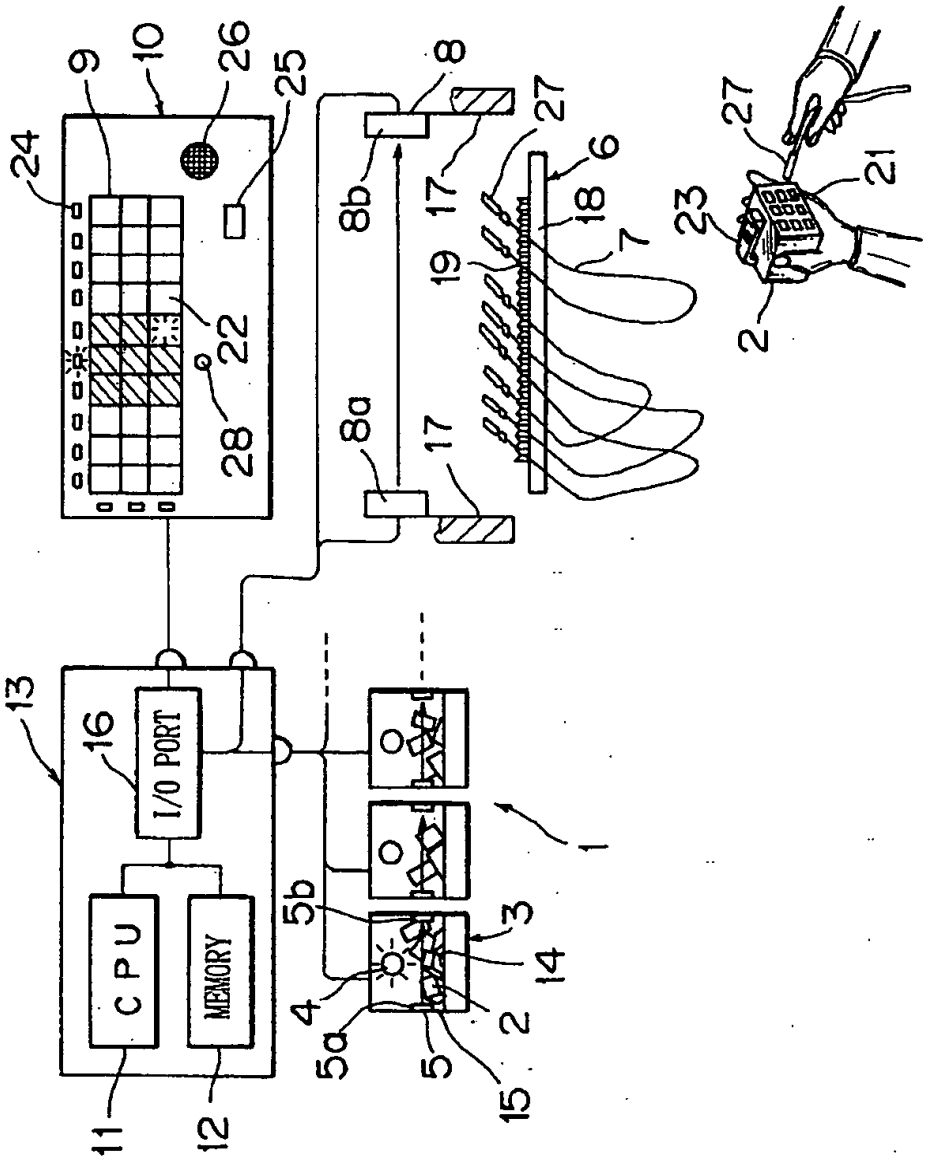

9
10
26
25
24
22
28
8
8b
8a
17
27
6
18
7
19
23
21
2
13
16
I/O PORT
CPU
MEMORY
11
12
1
3
14
4
5a
5b
5
15

FIG. 2

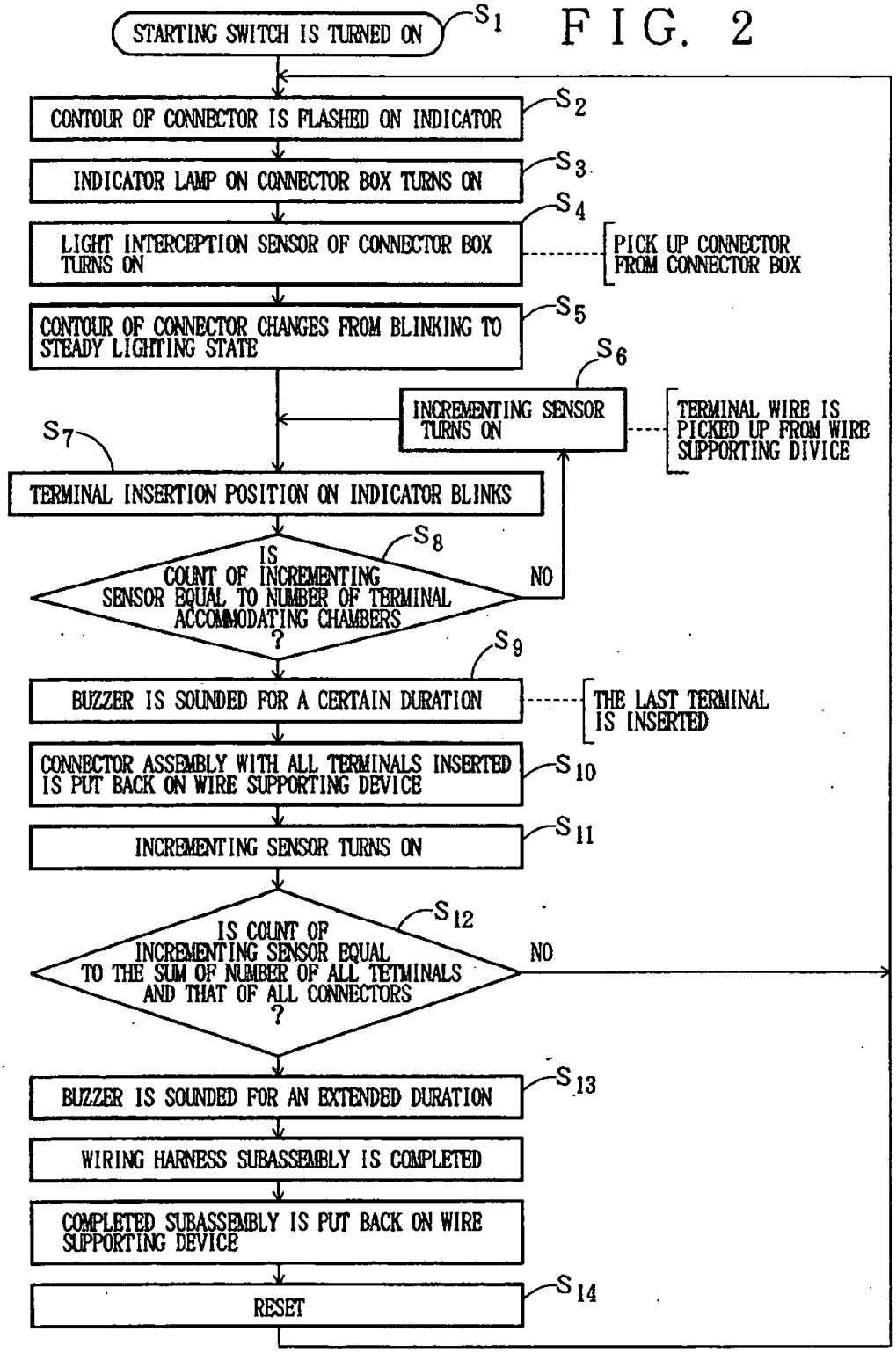

STARTING SWITCH IS TURNED ON
S1
CONTOUR OF CONNECTOR IS FLASHED ON INDICATOR
S2
INDICATOR LAMP ON CONNECTOR BOX TURNS ON
S3
LIGHT INTERCEPTION SENSOR OF CONNECTOR BOX TURNS ON
S4
PICK UP CONNECTOR FROM CONNECTOR BOX
CONTOUR OF CONNECTOR CHANGES FROM BLINKING TO STEADY LIGHTING STATE
S5
INCREMENTING SENSOR TURNS ON
S6
TERMINAL WIRE IS PICKED UP FROM WIRE SUPPORTING DIVICE
S7
TERMINAL INSERTION POSITION ON INDICATOR BLINKS
IS COUNT OF INCREMENTING SENSOR EQUAL TO NUMBER OF TERMINAL ACCOMMODATING CHAMBERS ?
S8
NO
BUZZER IS SOUNDED FOR A CERTAIN DURATION
S9
THE LAST TERMINAL IS INSERTED
CONNECTOR ASSEMBLY WITH ALL TERMINALS INSERTED IS PUT BACK ON WIRE SUPPORTING DEVICE
S10
INCREMENTING SENSOR TURNS ON
S11
IS COUNT OF INCREMENTING SENSOR EQUAL TO THE SUM OF NUMBER OF ALL TETMINALS AND THAT OF ALL CONNECTORS ?
S12
NO
BUZZER IS SOUNDED FOR AN EXTENDED DURATION
S13
WIRING HARNESS SUBASSEMBLY IS COMPLETED
COMPLETED SUBASSEMBLY IS PUT BACK ON WIRE SUPPORTING DEVICE
RESET
S14

FIG. 3

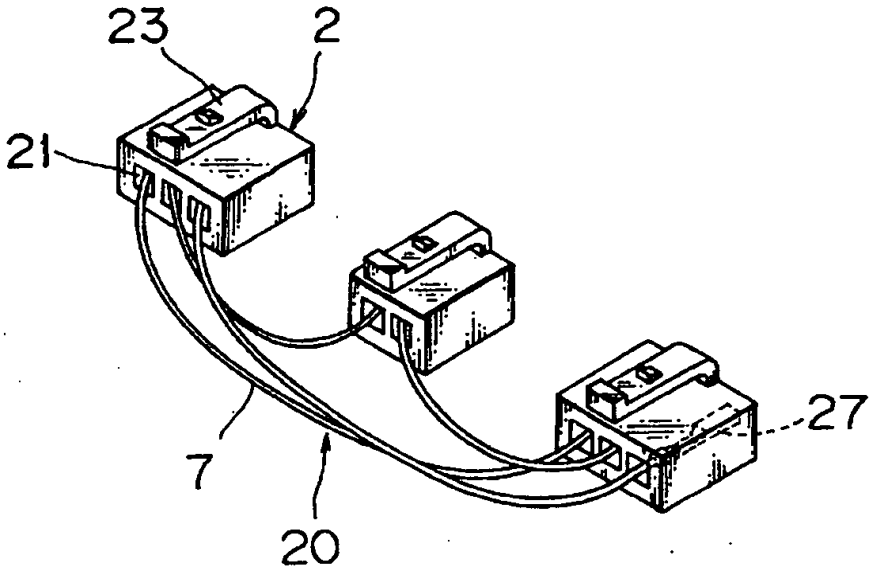
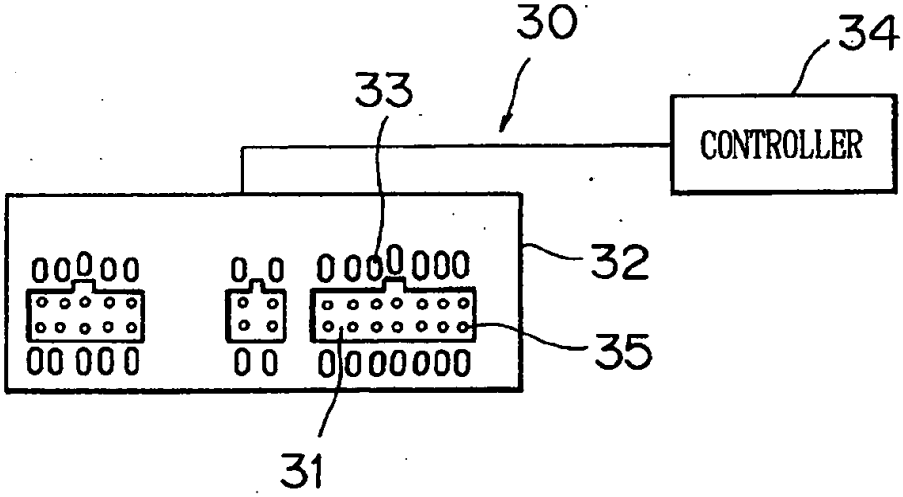


FIG. 4 PRIOR ART



ASSEMBLY GUIDING APPARATUS FOR WIRING HARNESS SUBASSEMBLIES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an assembly guiding apparatus for wiring harness subassemblies that facilitates the assembly work by indicating a connector to be bused and a position in the connector into which a terminal is to be inserted.

2. Description of the Prior Art

FIG. 4 shows a conventional assembly guiding apparatus for wiring harness subassemblies.

The assembly guiding apparatus **30** includes a connector receptor device **32**, which is provided with a plurality of connector insertion holes **31** and with a plurality of indicator lamps **33** corresponding to terminal accommodating chambers in a connector (not shown). The apparatus also includes a controller **34** which successively displays on the indicator lamps **33** the order of inserting terminals into the connector set in the insertion holes.

A check on terminal insertion is made by conduction pins **35** provided in the connector insertion holes **31**. A signal from a conduction pin **35** works as a trigger to cause the next terminal position to be indicated. Terminated wires are arranged in line on a rod-like wire supporting device (not shown) so that a worker can take the terminal wires successively, starting from the end of the wire supporting device, to insert them into the connector.

With the above-mentioned conventional apparatus, however, because the connector receptor device **32** can accept only a particular shape of connector, processing a variety of kinds of connectors requires many kinds of connector receptor devices **32**. Not only is this costly, but it increases the size of the apparatus **30**, making it impossible to deal swiftly with unexpected design changes and inevitably increasing the number of preparatory steps required to switch the type of wiring harness to be assembled.

SUMMARY OF THE INVENTION

In light of the above drawbacks, the present invention is intended to provide an assembly guiding apparatus for wiring harness subassemblies, which can guide the terminal assembly procedure for a variety of connector types and which is advantageous in terms of cost, is not large in size, requires no additional preparatory steps for switching the type of wiring harness, and can cope with unexpected design changes.

To achieve the above objectives, the assembly guiding apparatus for wiring harness subassemblies according to this invention comprises: a plurality of connector boxes containing connectors, each of which is provided with an indicator lamp and a light interception sensor facing a connector pick-up opening; an incrementing sensor installed on the pick-up side of terminated wires that are arranged in line on a rod-like wire supporting device; an indicator that indicates with light a contour of the connector and positions of terminal accommodating chambers in the connector; and a controller incorporating a CPU and a memory, both connected to the indicator lamp, the light interception sensor, the incrementing sensor and the indicator; wherein the controller displays the connector's contour stored in the memory onto the indicator, turns on the indicator lamp of the connector box containing connectors whose shape is the same as that of the contour stored in the memory, and successively displays on the indicator the positions of the terminal accommodating chambers stored in the memory each time the incrementing sensor is activated.

The shape of the connector to be used is displayed blinking. At the same time, the indicator lamp of one of the connector boxes that contains a connector to be used is blinked. When a worker picks up a connector from the indicated connector box, the light interception sensor is activated to detect the connector removal and make preparations for the next assembly procedure, such as displaying the connector contour on the indicator. Next, when the worker picks up a terminated wire from the wire supporting device, the incrementing sensor is activated to indicate the position where the terminal should be inserted, as by blinking of that position. The worker can now watch the indicator and insert the terminals one after another according the display until a wiring harness subassembly consisting of a plurality of connectors and terminated wires is completely assembled.

Other features and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram showing the overall view of one embodiment of the assembly guiding apparatus for wiring harness subassemblies according to this invention;

FIG. 2 is a flowchart of the operation of the apparatus;

FIG. 3 is a perspective view showing a completed wiring harness subassembly; and

FIG. 4 is an overall schematic view of a conventional apparatus.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows one embodiment of the assembly guiding apparatus for wiring harness subassemblies according to this invention.

The assembly guiding apparatus **1** comprises: a plurality of connector boxes **3** each containing one of different kinds of connectors **2**; an indicator lamp **4** and light interception sensor **5**, both installed in each connector box **3**; an incrementing sensor **8** of light interception type installed on the pick-up side of terminated wires **7** that are arranged in line on a rod-like wire supporting device **6**; an indicator **10** having a display **9** that indicates with light a contour of the connector **2** and positions of terminal accommodating chambers in the connector **2**; and a controller **13** incorporating a CPU (central processing unit) **11** and a memory **12** and connected to the light interception sensor **5**, the incrementing sensor **8** and the indicator **10**.

The connector boxes **3** are arranged in line widthwise and each contain one of different kinds of connectors **2**. The indicator lamp **4** is installed at the upper part of each of the boxes **3** to indicate from which box the connector **2** should be taken out. On the side walls **15** of each box **3** is installed the light interception sensor **5** made up of opposed light emitting element **5***a* and light receiving element **5***b*. The light interception sensor **5** is turned on when the light is intercepted by hand of an assembly worker who picks up the connector. The indicator lamp **4** and the light interception sensor **5** are connected to the CPU **11** and memory **12** via an I/O port **16** in the controller **13**.

The incrementing sensor **8** and the indicator **10** are both connected to the CPU **11** and the memory **12** through the I/0 port **16**. The incrementing sensor **8**, like the light interception sensor **5**, consists of opposed light emitting element **8***a* and light receiving element **8***b*, both arranged on vertical walls **17** located on both sides of the wire supporting device **6**, and is turned on when intercepted by a hand of the worker picking up the terminated wire **7** from the wire supporting device **6**. To prevent undesired detection of details of the worker's hand, such as individual fingers, the incrementing sensor **8** is given a time constant to prevent chattering. The wire supporting device **6** is of a known type in which a plurality of wire clips **19** are erected on a rod portion **18**. The terminated wires **7** are fitted in the clips **19** in the order of use, beginning with one end of the wire supporting device **6** and ending with the other end. The wire supporting device **6** is changed according to the kind of the wiring harness subassembly **20** (FIG. **3**). The indicator **10** comprises: a display **9** consisting of a partitioned area **22** having a plurality of light emitting diodes (LEDs) that correspond to individual terminal accommodating chambers **21** (FIG. **3**) in the connector **2**; a plurality of lock position indicator lamps (LEDs) **24** arranged around the display **9** to indicate the position of a lock arm **23** of the connector **2** for easy identification of top and bottom of the connector **2**; a starting switch **25** to turn on the lamps **4**, **24** and the display **9**; and a buzzer **26** to inform the worker of the incrementing timing. The worker, while watching the display **9** of the indicator **10**, inserts the terminals **27** into the connector **2** held by the hand.

FIG. **2** shows the operation flow of the above-mentioned assembly guiding apparatus. When the starting switch **25** is turned on (S1), the contour of the connector to be used is displayed flashing on the indicator **10** (S2) and at the same time the indicator lamp **4** on the connector box **3** blinks (S3). The kinds of connectors **2** to be used are entered beforehand into the memory **12** in the order of use. When a worker picks up a connector **2** from the connector box **3** indicated by the indicator lamp **4**, the light interception sensor **5** turns on (S4) to change the lighting state of the connector contour on the indicator **10** from blinking to steady state lighting (S5).

Next, when the worker picks up a terminated wire **7** from the wire supporting device **6**, the incrementing sensor **8** turns on (S6) to blink the terminal insertion position on the indicator **10** (S7), indicating the terminal accommodating chamber **21** into which the terminal **27** is to be inserted. The operation of the incrementing sensor **8** and the blinking of the terminal insertion position on the indicator **10** are repeated (S2–S7) until all the terminals **27** are inserted into the connector **2** or until the count of the incrementing sensor **8** is equal to the number of terminal accommodating chambers **21** in the connector **2** stored in the memory (S8). When the insertion position in the connector **2** for the last terminal **27** is blinked, the buzzer **26** is sounded for a certain duration and a lamp **28** on the indicator **10** is lighted (S9), informing the worker that the terminal **27** the worker is going to install is the last one (i. e., there is only one terminal accommodating chamber **21** left that should be inserted into).

Upon hearing the sounding buzzer **26**, the worker puts the connector assembly (with all terminals inserted) back on the wire supporting device **6** (S10). This causes the incrementing sensor **8** to turn on (S11) and the above series of operations from S2 to S11 are repeated until the count of the incrementing sensor **8** is equal to the sum of the number of all terminals of the wiring harness subassembly **20** and the number of all connectors (S12). When, after all the terminals **27** are inserted into the connector **2** (completing a wiring harness subassembly **20** as shown in FIG. **3**, for example), the last connector assembly is returned onto the wire supporting device **6**, the buzzer **26** is sounded for an extended duration, notifying the worker of the completion of the assembly work (S13). At the same time, the guiding apparatus **1** is reset to the initial value (S14), giving instructions for the next assembly work.

With this invention, because the indicator displays the connector contour and the terminal insertion position, the guiding of the terminal insertion procedure can be done for any shape of connector by simply changing the data entered into the memory. This in turn enables changes in design and switching of wiring harness type to be dealt with quickly by making simple changes in software and also reduces the size of the apparatus when compared with the conventional one, lowering the cost and simplifying the work procedures. Furthermore, because the worker can hold the connector and insert terminals while watching the indicator, the work efficiency is improved.

While the invention has been described with reference to specific embodiments, the description is illustrative and is not to be construed as limiting the scope of the invention. Various modifications and changes may occur to those skilled in the art without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. An assembly guiding apparatus for wiring harness subassemblies comprising:

a plurality of connector boxes containing connectors, each of which is provided with an indicator lamp and a light interception sensor facing a connector pick-up opening;

an incrementing sensor installed on the pick-up side of terminated wires that are arranged in line on a wire supporting device, said incrementing sensor being of a light intercepting sensor;

an indicator that indicates with light a contour of the connector and positions of terminal accommodating chambers in the connector; and

a controller incorporating a CPU and a memory, both connected to the indicator lamp, the light interception sensor, the incrementing sensor and the indictor;

wherein the controller displays the contour of the connector stored in the memory onto the indicator, turns on the indicator lamp of the connector box containing connectors whose shape is the same as that of the contour stored in the memory, and successively displays on the indicator the positions of the terminal accommodating chambers stored in the memory each time the incrementing sensor is activated.

2. An assembly guiding apparatus for wiring harness subassemblies according to claim **1**, further comprising a means to annunciate when there is only one terminal accommodating chamber left in each connector being assembled.

3. An assembly guiding apparatus for wiring harness subassemblies according to claim **1**, further comprising:

a count means linked to the incrementing sensor to detect the number of remaining terminal accommodating chambers in the connector; and

an annunciator means which is activated when the number of remaining terminal accommodating chambers in the connector is one.

4. An assembly guiding apparatus for wiring harness subassemblies according to claim **1** to **3**, wherein a means is provided to annunciate when there is only one terminal accommodating chamber left in the wiring harness subassembly being assembled, and the indicator and counter are reset to the initial value when the completed wiring harness

subassembly is put back on the wire supporting device.

5. An assembly guiding apparatus for wiring harness subassemblies according to claim 1 to 3, further comprising:

a count means linked to the incrementing sensor to count the sum of the number of all terminals in the wiring harness subassembly and the number of all connectors when a terminal is taken from the wire supporting device and when the connector is put back onto the wire supporting device; and

an annunciator and a reset means, both activated when the sum is counted.

* * * * *

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(12) **United States Patent**
Takada

(10) **Patent No.: US 6,269,538 B1**
(45) **Date of Patent: *Aug. 7, 2001**

(54) **PRESS FITTING APPARATUS FOR MANUFACTURING A WIRING HARNESS**

(75) Inventor: **Kazuhiko Takada**, Shizuoka (JP)

(73) Assignee: **Yazaki Corporation**, Tokyo (JP)

(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/237,903**

(22) Filed: **Jan. 27, 1999**

Related U.S. Application Data

(62) Division of application No. 08/857,249, filed on May 16, 1997, now Pat. No. 5,913,553.

(30) **Foreign Application Priority Data**

May 20, 1996 (JP) 8-124967

(51) **Int. Cl.**[7] **H01R 43/04**

(52) **U.S. Cl.** ..... **29/867**; 29/863; 29/861; 29/749; 29/755; 29/33 F; 29/33 M

(58) **Field of Search** ..... 29/33 M, 33 F, 29/755, 749, 861, 867, 786, 748, 866, 863; 439/597, 599, 598

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Primary Examiner—Lee Young
Assistant Examiner—Minh Trinh
(74) *Attorney, Agent, or Firm*—Armstrong, Westerman, Hattori, McLeland, and Naughton, LLP

(57) **ABSTRACT**

A press-fitting unit includes a vertically movable press blade for press-fitting a stripped end of an electrical wire to a terminal disposed in a connector. A connector retaining bar movable in a horizontal direction is disposed to be opposed to the press blade. The retaining bar is provided with a plurality of connector receiving recesses in parallel to respectively hold a connector with a press-fit terminal. A wire chuck is disposed so as to opposing to the rear part of the press blade. The wire chuck is horizontally movable along a horizontal guide to a side of the press blade so as to holding the wire. Alternatively, the connector retaining bar is fixed to the apparatus by a frame and a transfer mechanism can carry the press-fitting unit along the bar in a horizontal direction. In addition, the apparatus may have a pair or two pairs of the upper and lower symmetrical press-fitting units; and the connector retaining bar is disposed between the upper and lower press-fitting units.

8 Claims, 21 Drawing Sheets

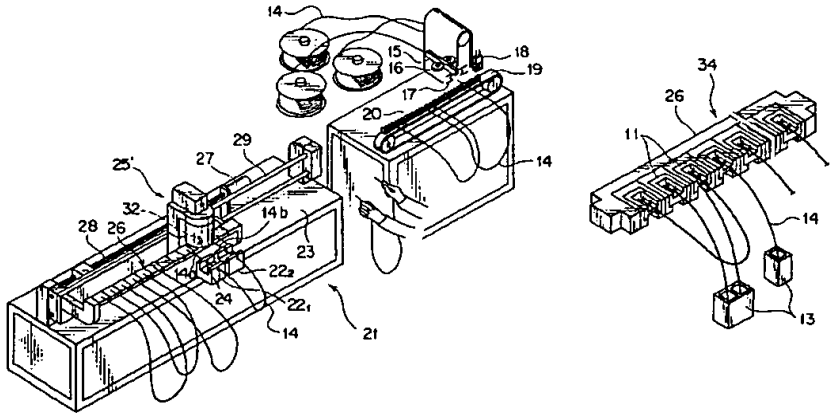


FIG. 1

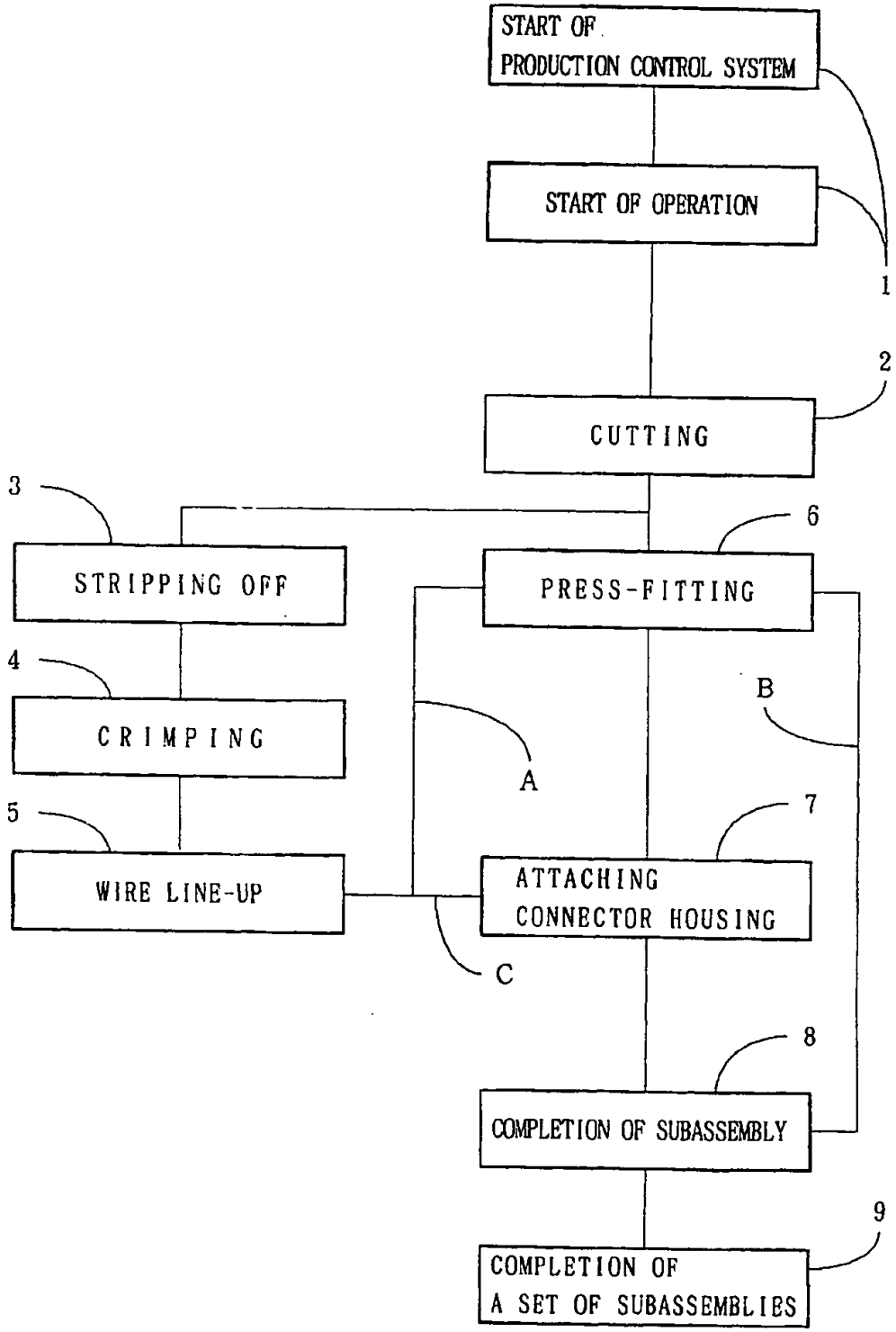

START OF PRODUCTION CONTROL SYSTEM
START OF OPERATION
1
2
CUTTING
3
STRIPPING OFF
4
CRIMPING
5
WIRE LINE-UP
6
PRESS-FITTING
A
B
7
ATTACHING CONNECTOR HOUSING
C
8
COMPLETION OF SUBASSEMBLY
9
COMPLETION OF A SET OF SUBASSEMBLIES

FIG. 2

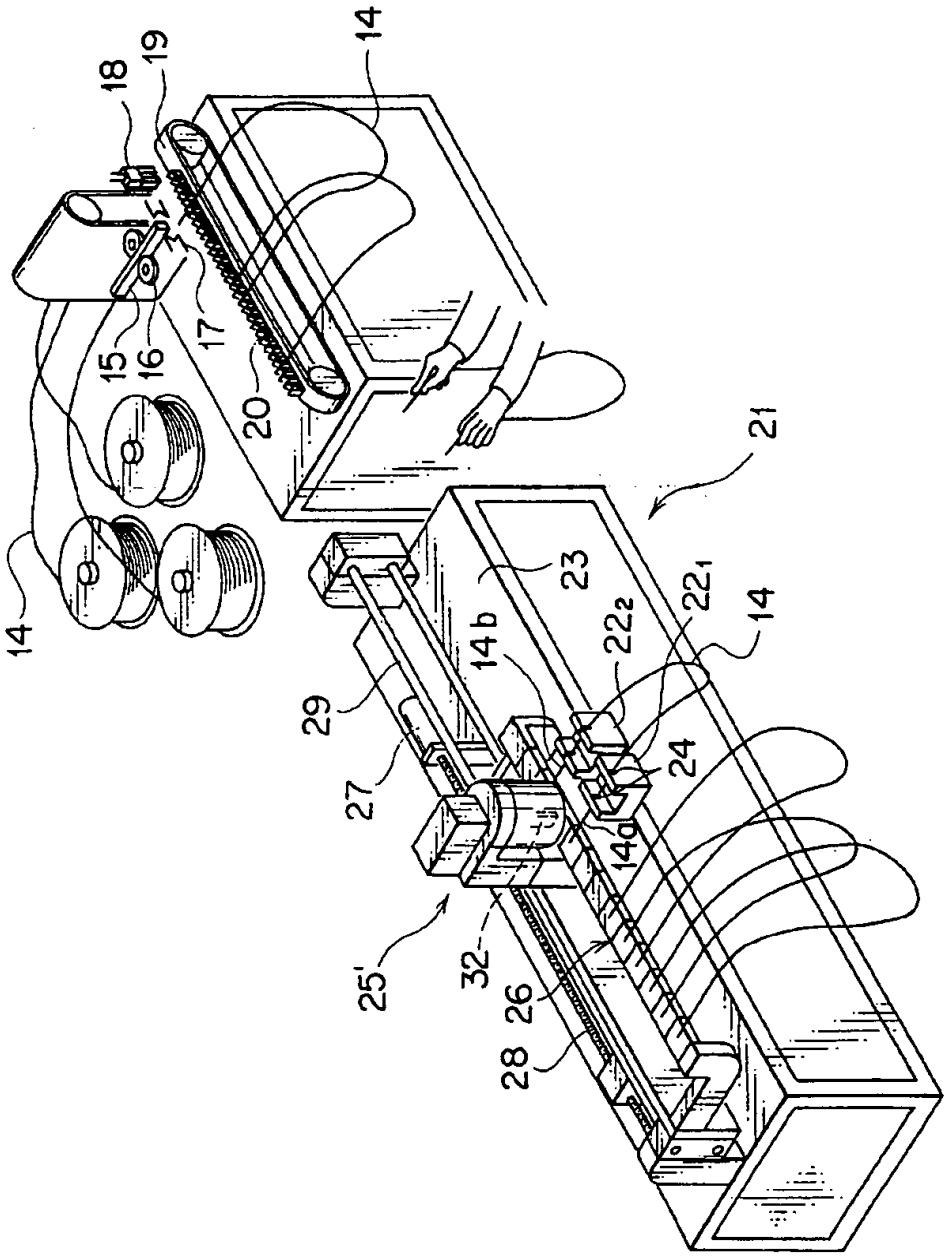


FIG. 3

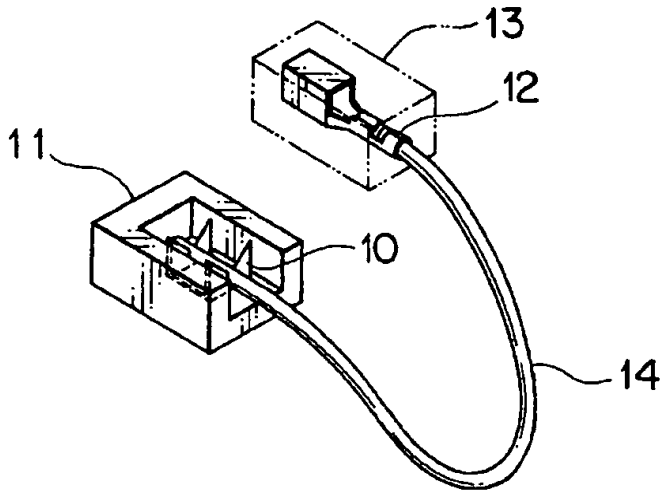


FIG. 4

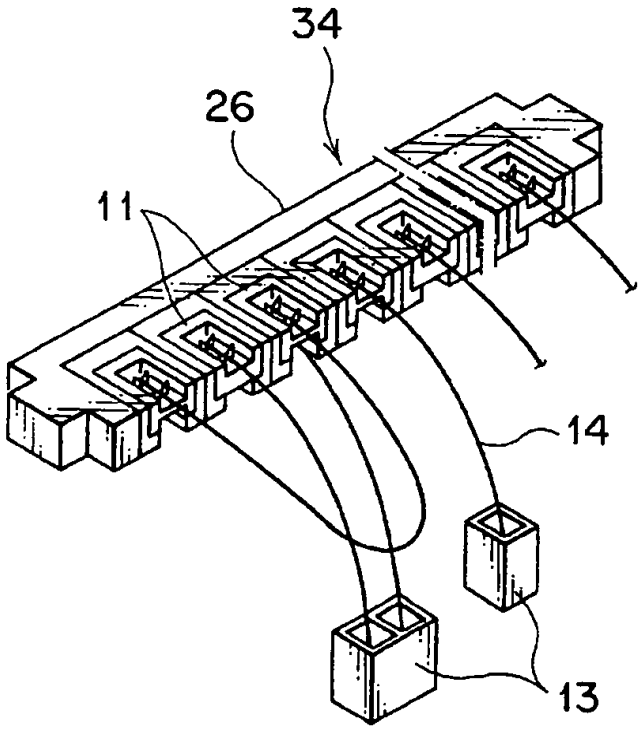


FIG. 5

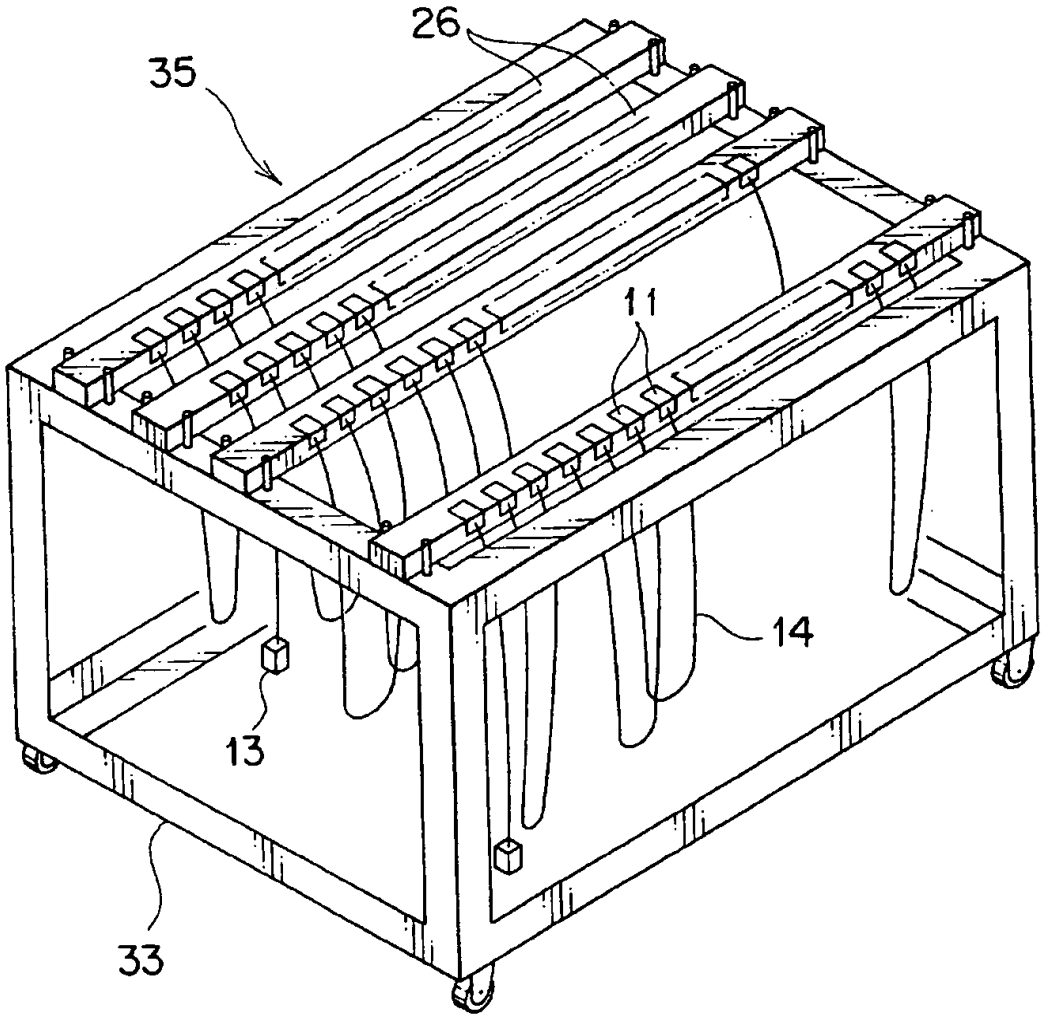
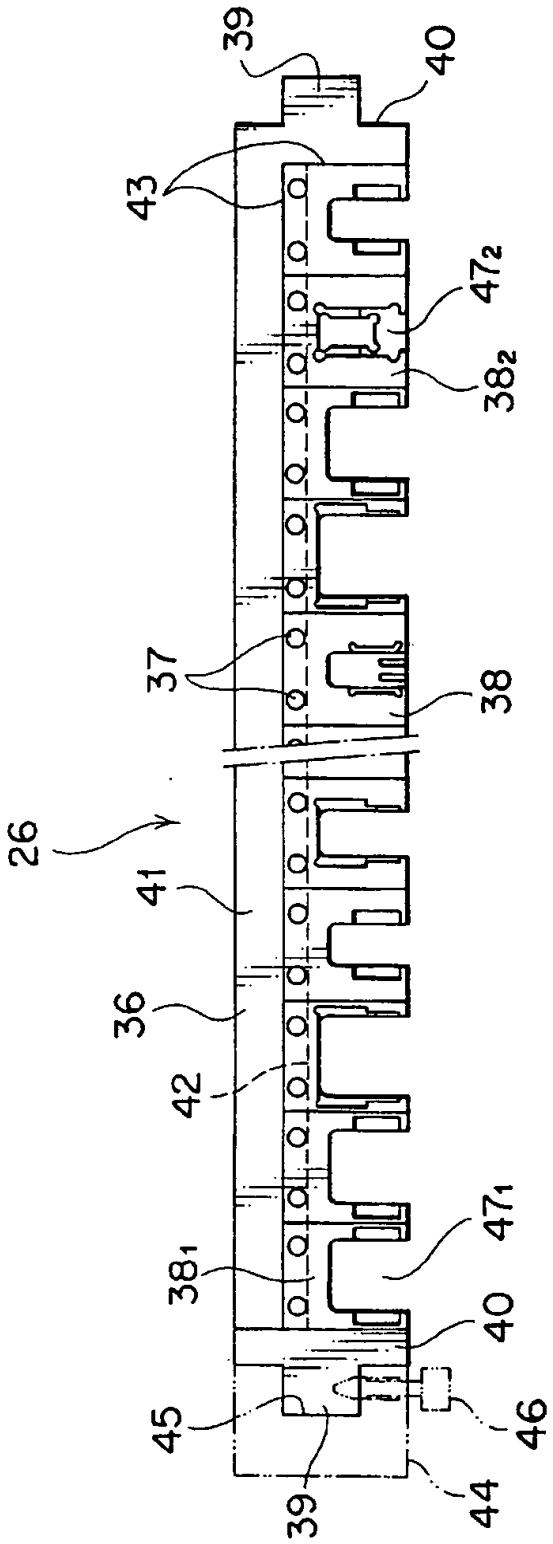


FIG. 6



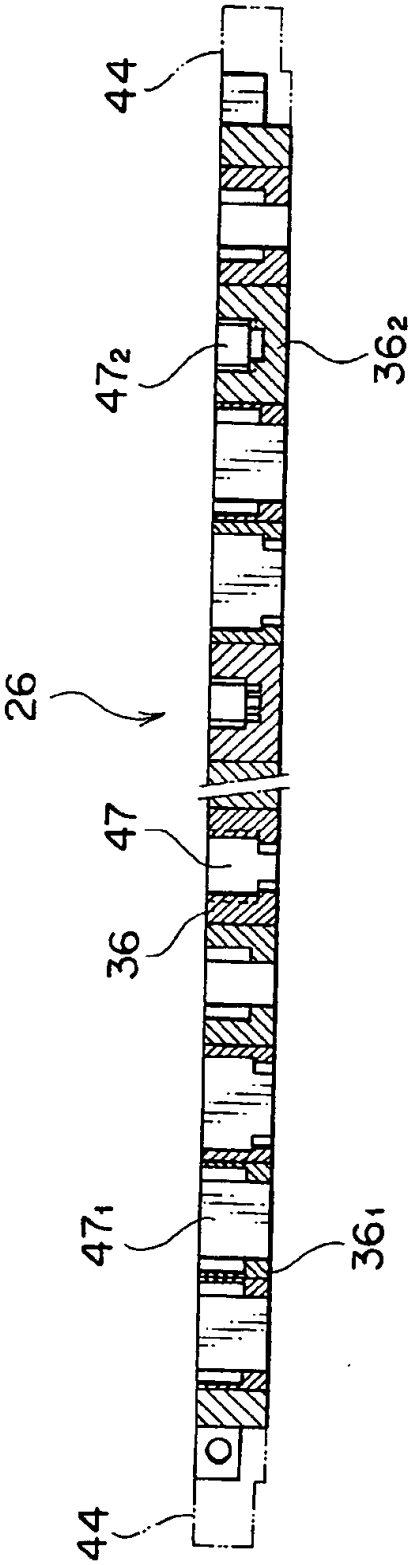


FIG. 7

FIG. 8

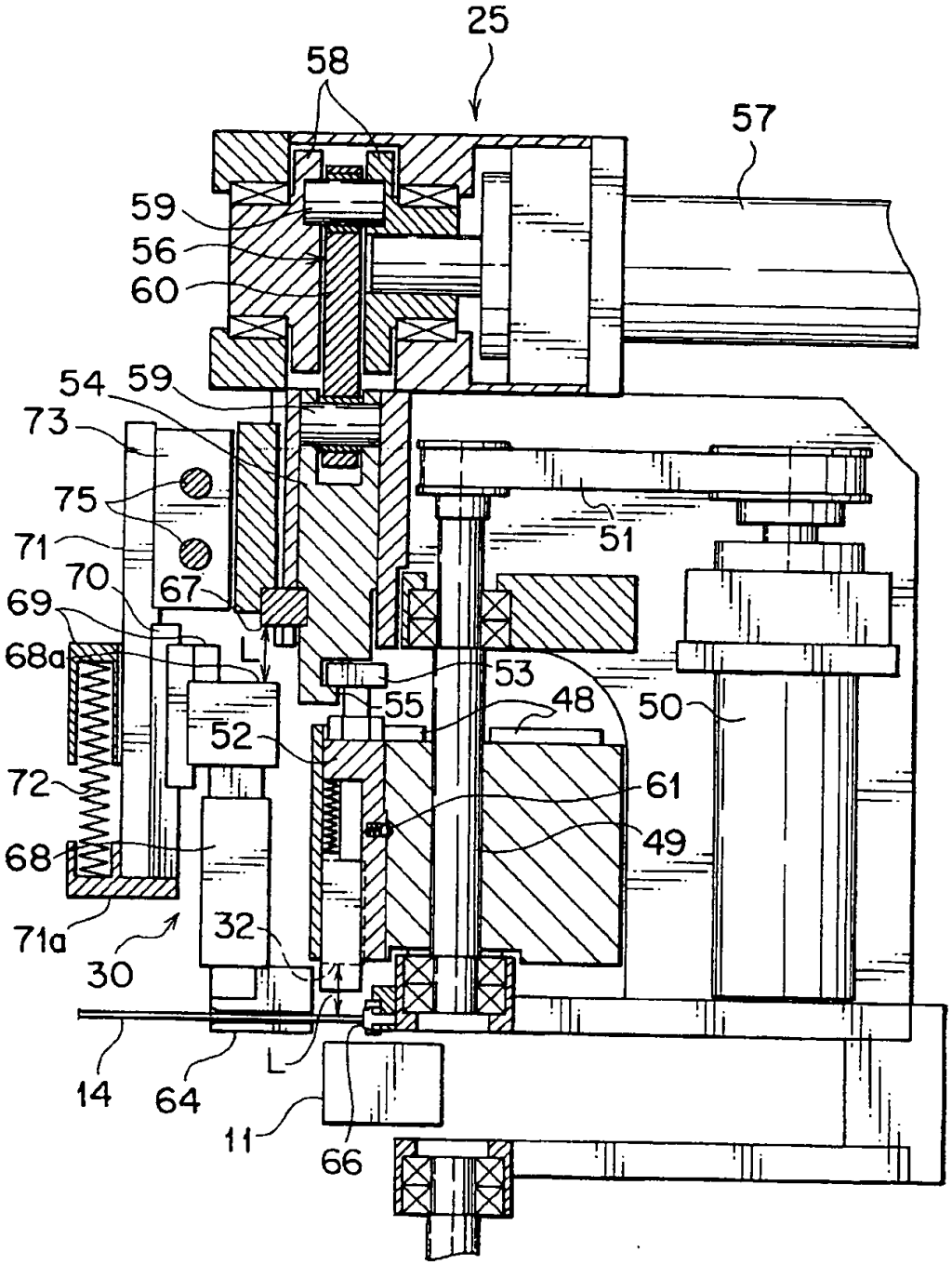

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FIG. 9

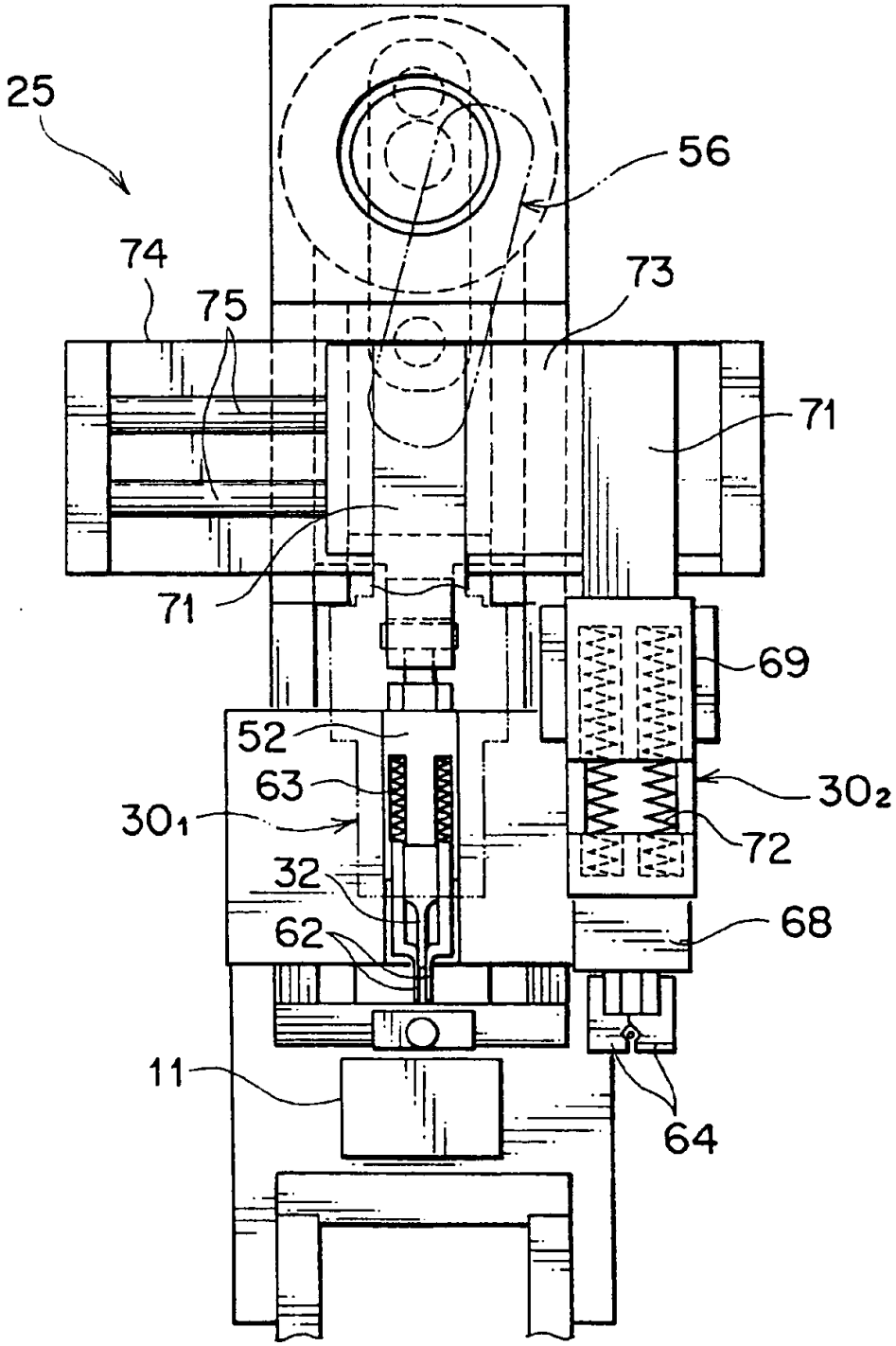


FIG. 10A

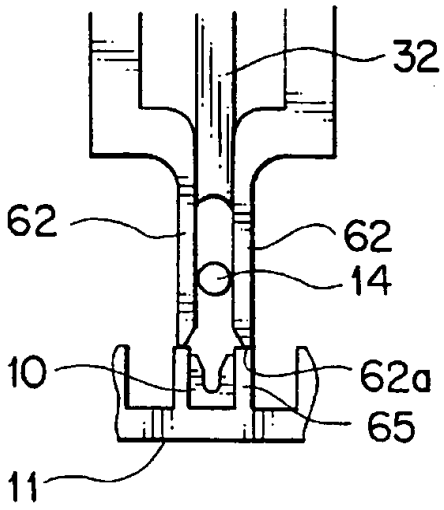


FIG. 10B

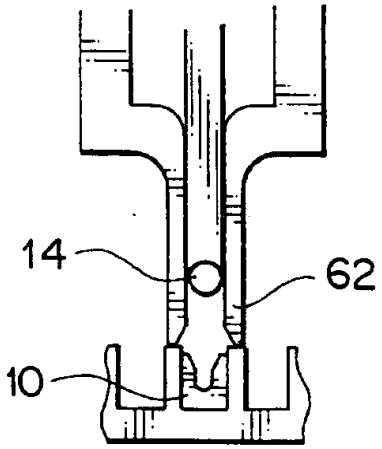


FIG. 10C

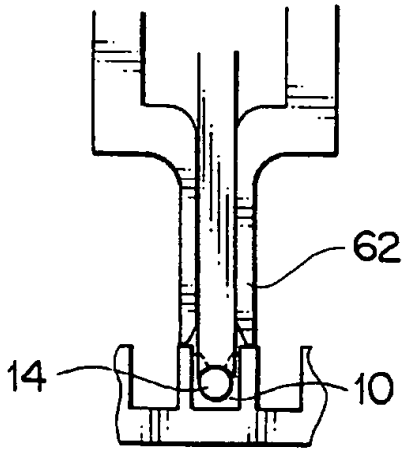
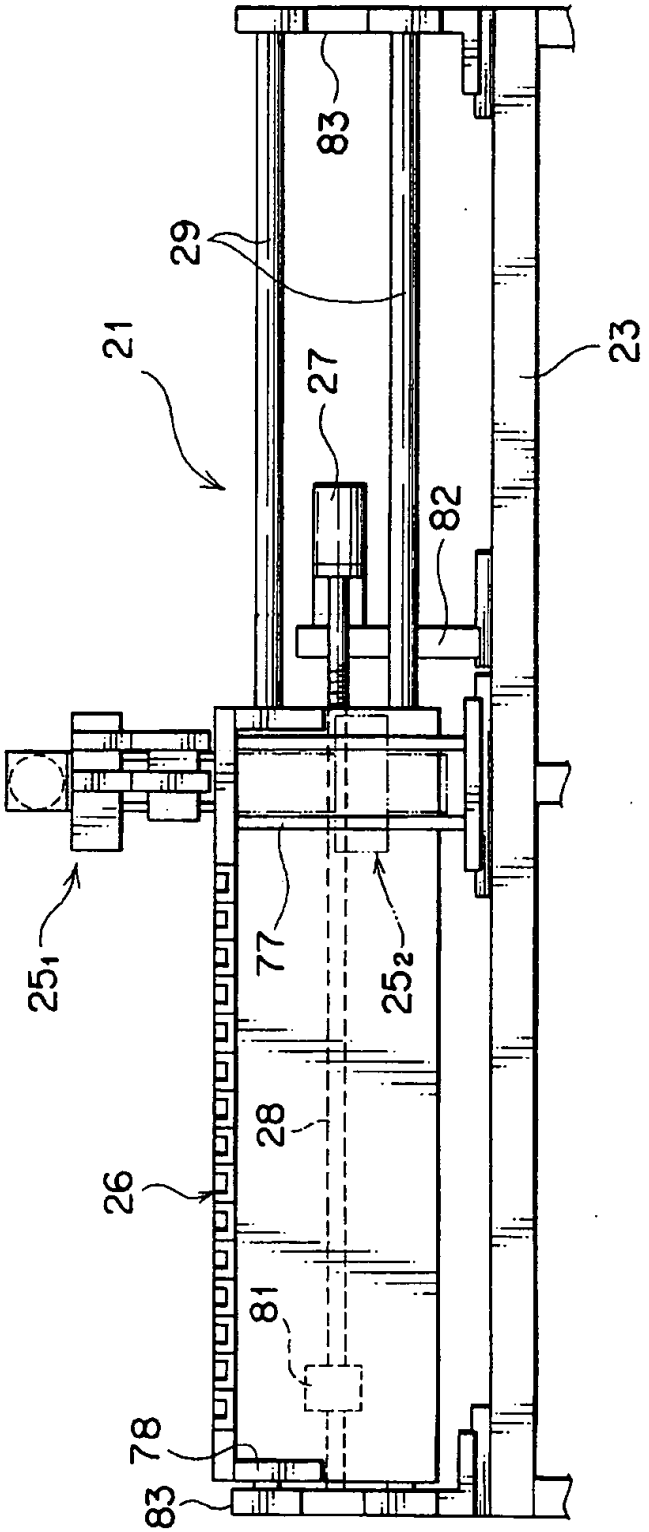


FIG. 11



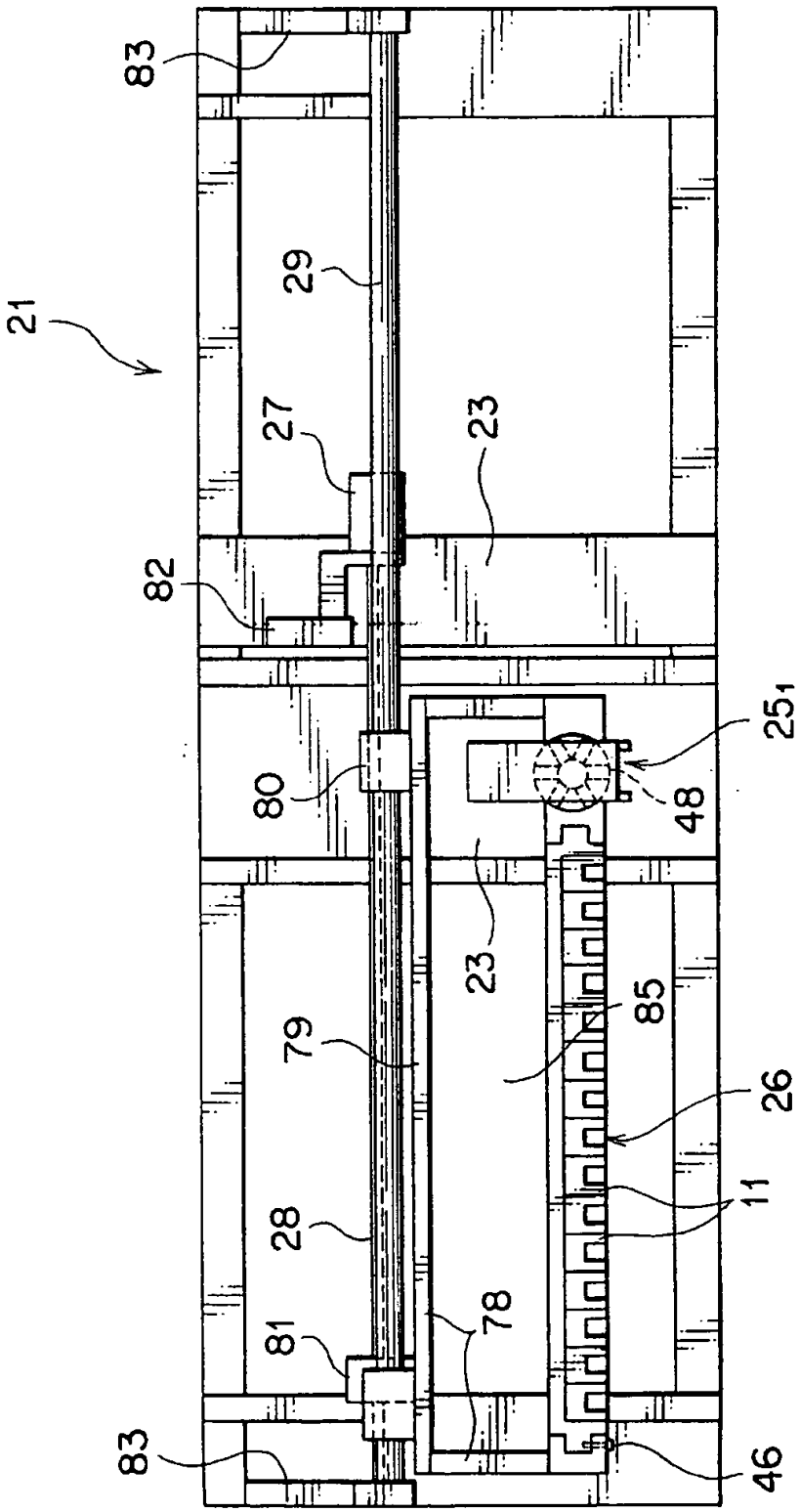
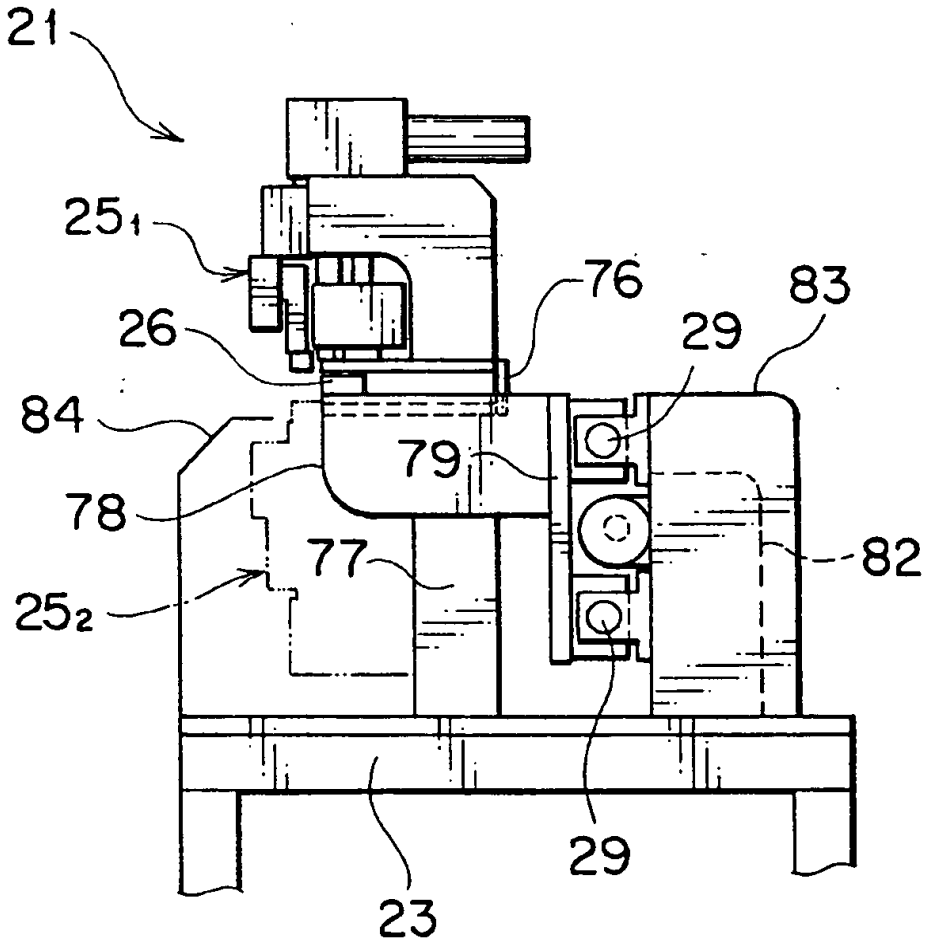


FIG. 12

FIG. 13



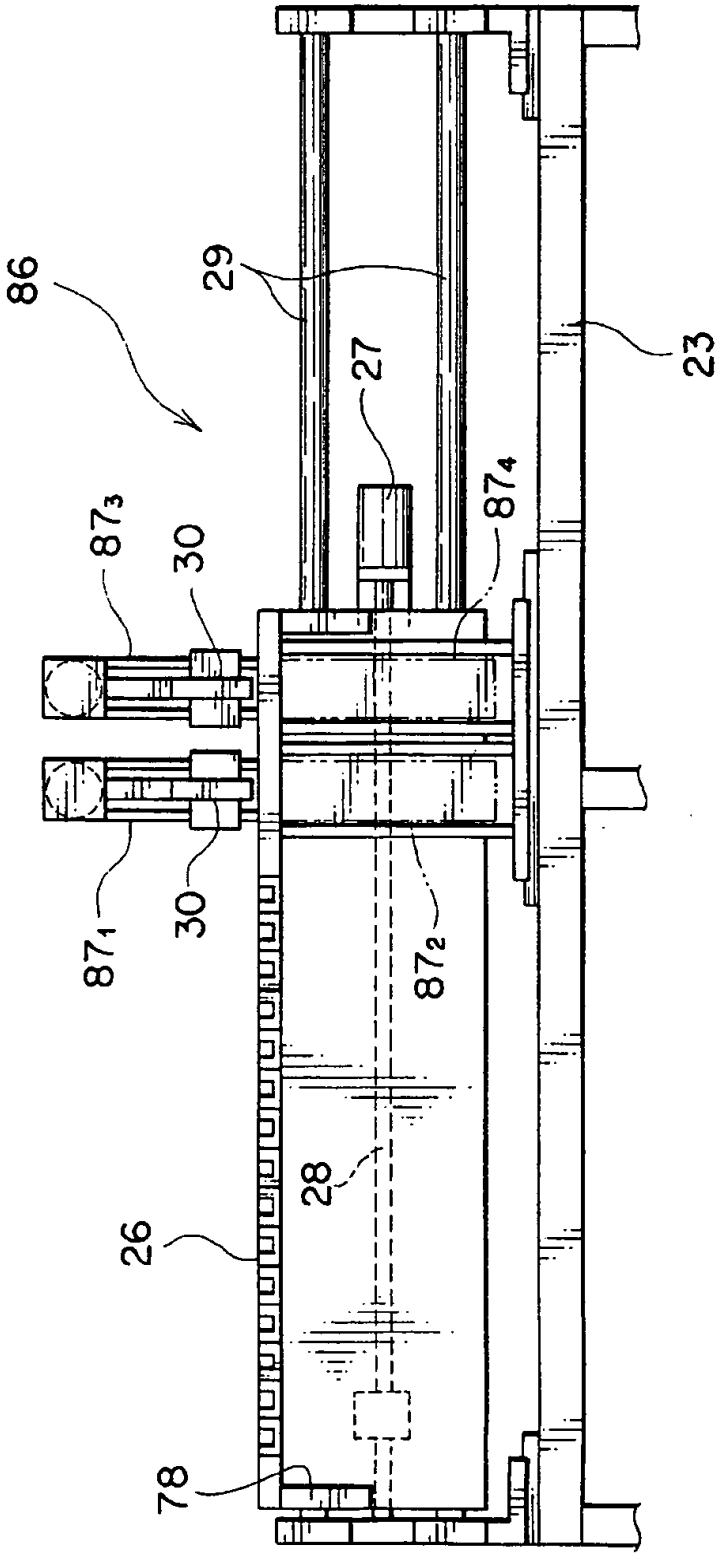


FIG. 14

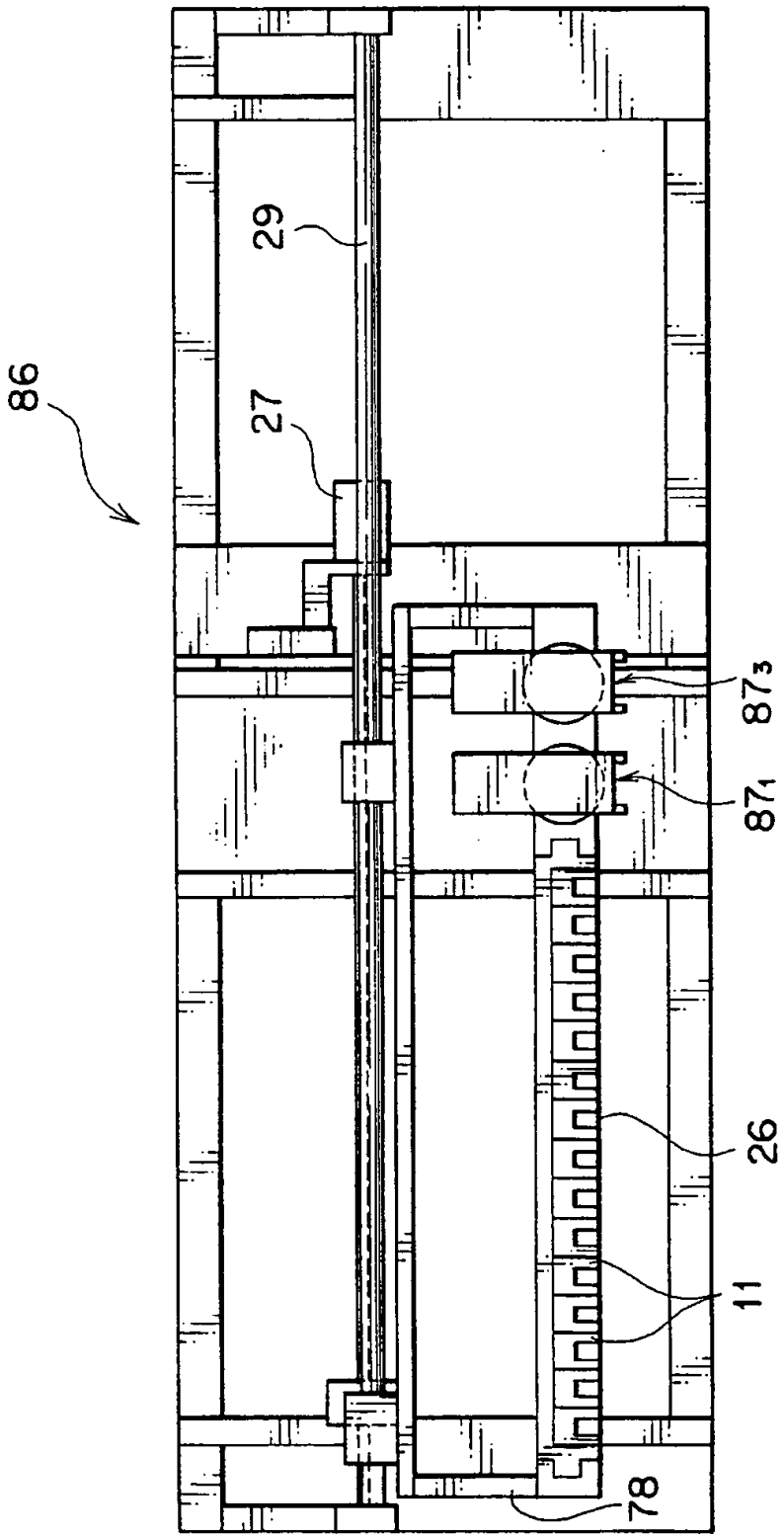


FIG. 15

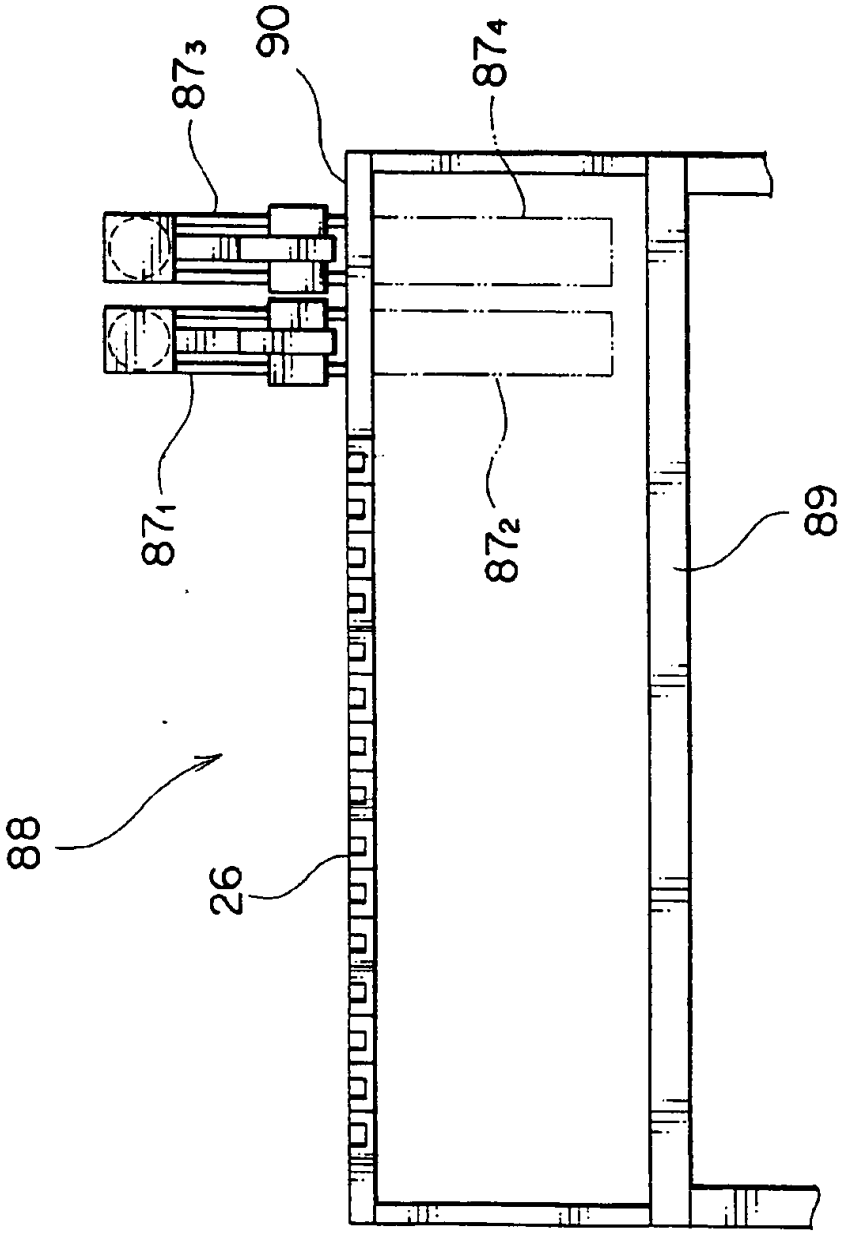


FIG. 16

FIG. 17

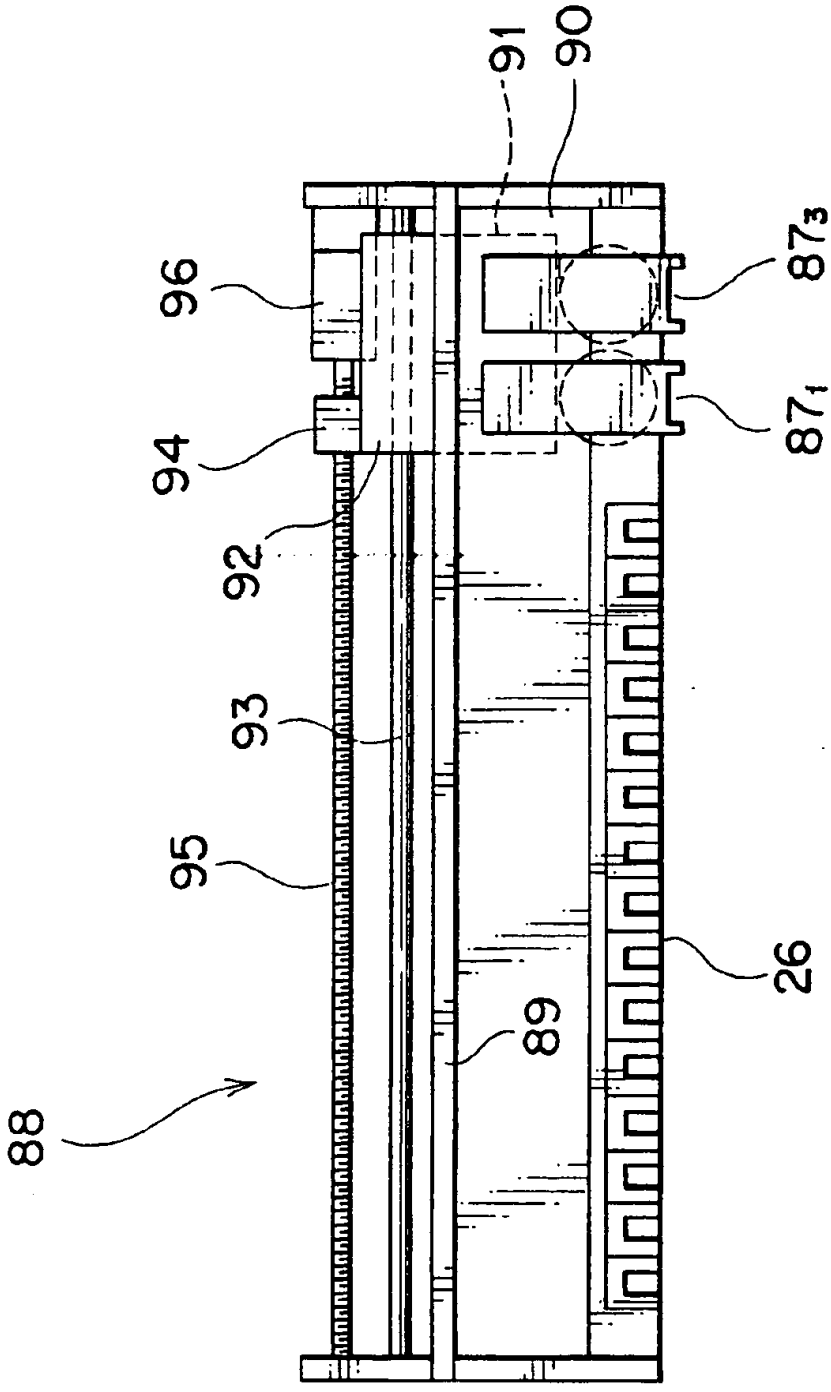


FIG. 18
PRIOR ART

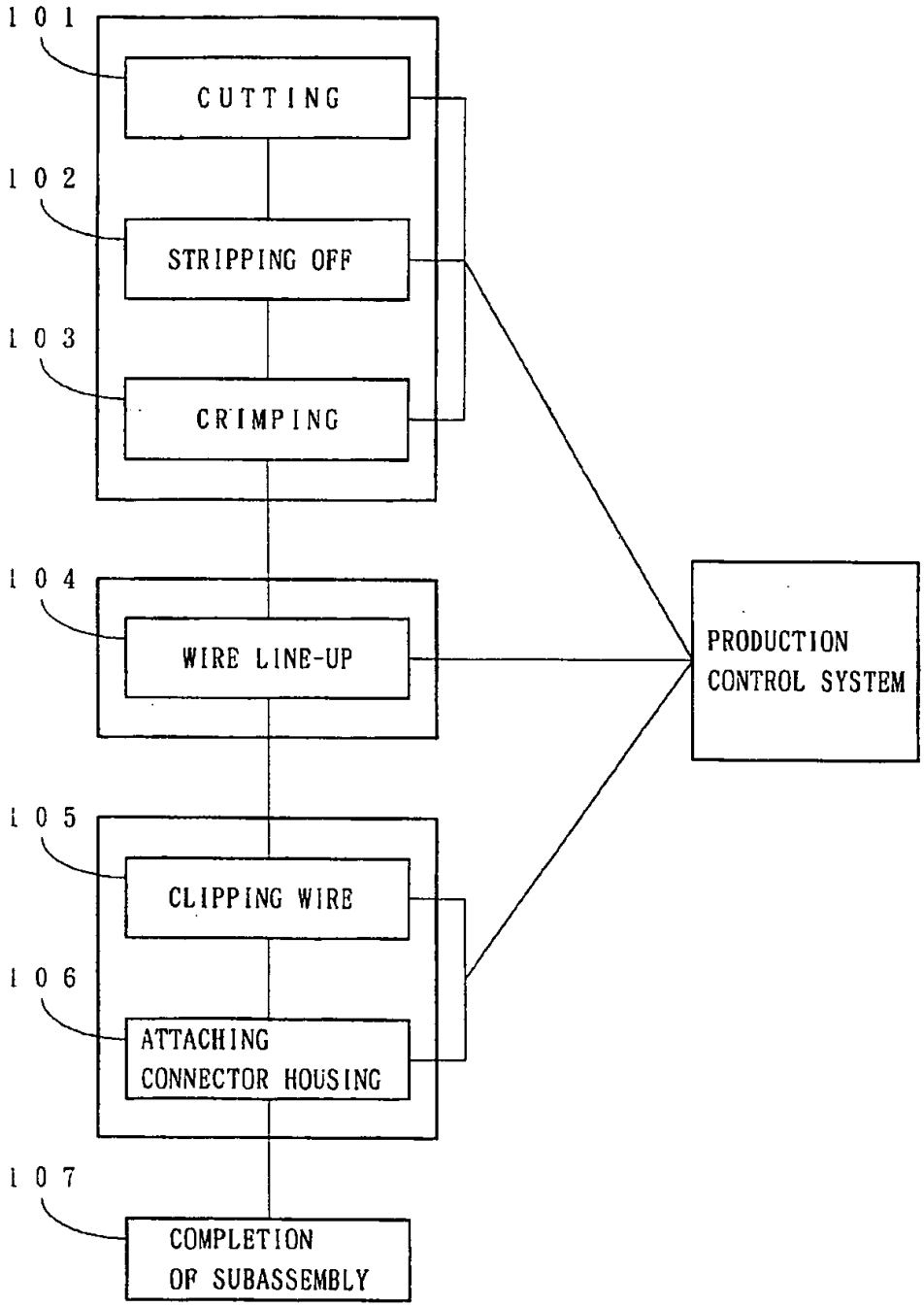


FIG. 19
PRIOR ART

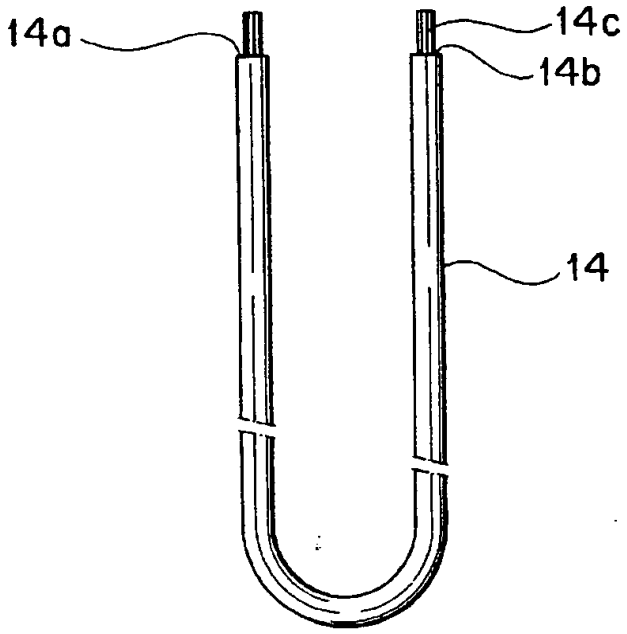


FIG. 20
PRIOR ART

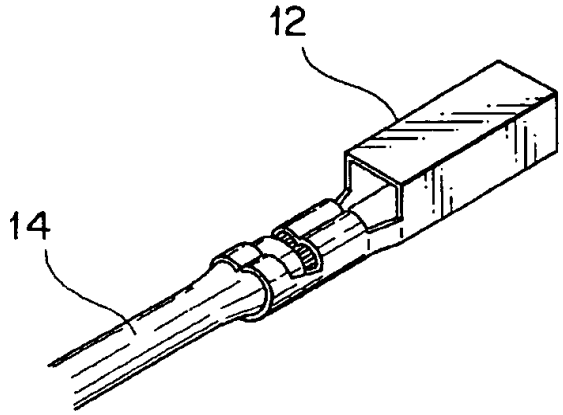


FIG. 21
PRIOR ART

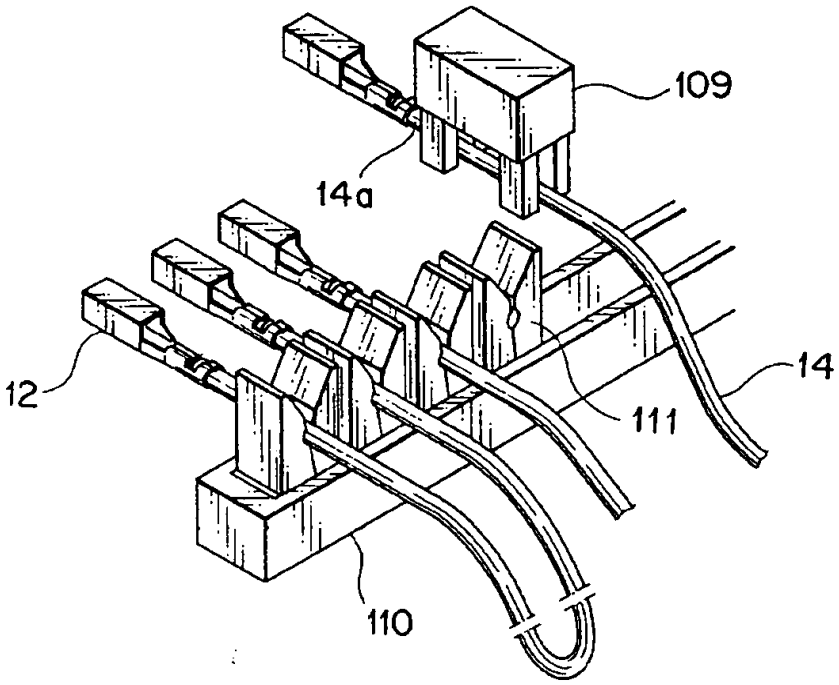


FIG. 22
PRIOR ART

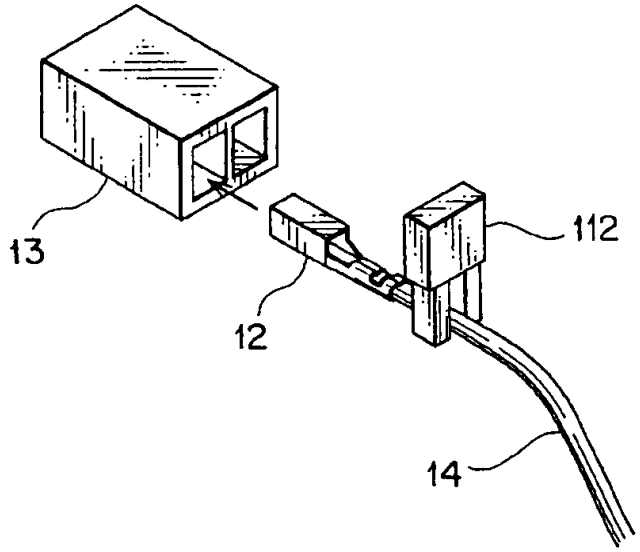


FIG. 23
PRIOR ART

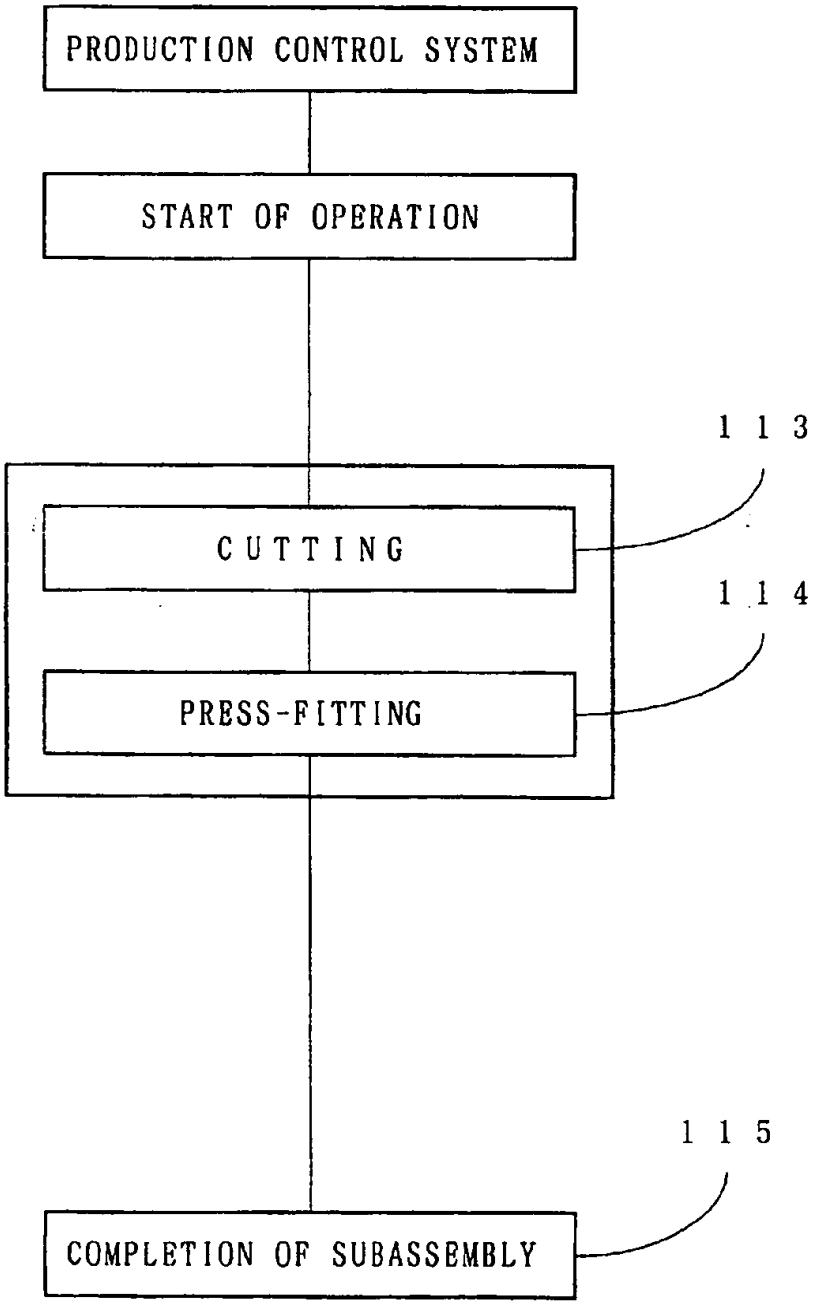
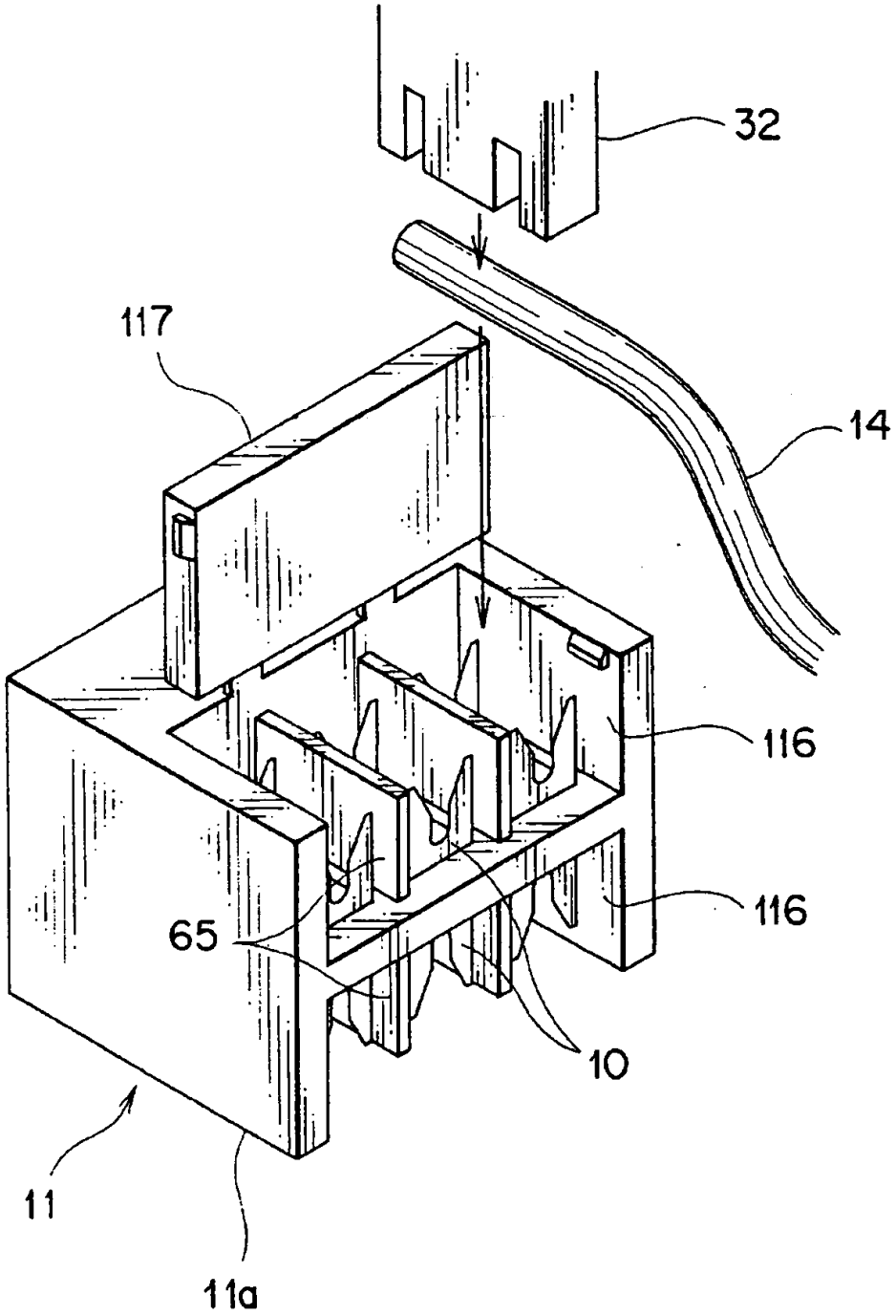


FIG. 24
PRIOR ART



PRESS FITTING APPARATUS FOR MANUFACTURING A WIRING HARNESS

This application is a division of Ser. No. 08/857,249 filed May 16, 1997 now U.S. Pat. No. 5,913,353.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a manufacturing method of a wiring harness subassembly having both crimp-type terminals and press-fit-type terminals. Further, the invention relates to equipment for implementation of the manufacturing method, which includes a press-fitting unit, a connector retaining bar holding connectors in parallel, and a press-fitting apparatus with the connector retaining bar.

2. Description of the Prior Art

FIGS. **18** to **22** show a known manufacturing method of a wiring harness using crimped terminals.

In the method, the first step is cutting an electrical wire **14** into desired lengths. Next, each end **14***a* or **14***b* of the wire **14** is stripped off to expose a conductor **14***c* (stages **101**, **102** in FIG. **18**) as illustrated in FIG. **19**. Then, the conductor **14***c* is crimped to a terminal **12** for connection (stage **103** in FIG. **18**) as illustrated in FIG. **20**. And, after correct arrangement (stage **104** in FIG. **18**) of the wire **4** with the terminal, a chuck **109** holds the wire **14** near the end **14***a*. Further, the terminal equipped wires are sequentially forced into clips **111** formed in a wire retaining bar **110** (stage **105** in FIG. **18**) as illustrated in FIG. **21**. Finally, with picking up an end portion of the wire **14** from the clip **111**, a chuck **112** inserts the terminal into a connector housing **13** (stage **106** in FIG. **18**) as illustrated in FIG. **22**. Thence, these steps complete a wiring harness subassembly (stage **107** in FIG. **18**).

Meanwhile, FIGS. **23** to **24** show another known manufacturing method of a wiring harness using a press-fit terminal **10**. In the method, a wire **14** having been cut into a desired length, without stripping off each end thereof, is forced to enter into a press-fit terminal **10** disposed in a connector housing **11***a* by a vertically moving blade **32** (stages **113** and **114**). The application of these steps to plural connector **11** competes a wiring harness subassembly (stage **115** in FIG. **23**).

The connector **11** has press-fit terminals **10** disposed in upper and lower open compartments **116** formed between partitions in its connector housing **11***a* made of a synthetic resin (a double-sided press-fitting terminal connector). After the wires have been press-fitted, the closure of a cover plate **117** protects the press-fitted terminals.

However, in the known manufacturing method of a wiring harness using crimp terminals **12** is produced separately from a wiring harness utilizing press-fit terminals **10**. This has not been able to efficiently produce various types of wiring harnesses including both the crimp terminals **12** and the press-fit terminals **10**.

In view of the foregoing disadvantage, an object of the invention is to provide a manufacturing method of a wiring harness using both crimp terminals and press-fit terminals and to obtain means for the same, which includes a press--fitting apparatus.

SUMMARY OF THE INVENTION

For achieving the object, a manufacturing method of a wiring harness according to the invention includes the steps of:

stripping off one end of an electrical wire;

crimping the one end of the wire to a crimping terminal;

press-fitting the other end of the wire in a terminal of a connector; and

inserting the crimped terminal into a connector housing, which accomplishing a wiring harness subassembly having both the crimped wire end and the press-fitted wire end.

Another manufacturing method of a wiring harness according to the invention for press-fitting one stripped end of an electrical wire to a press-fit-type terminal of a connector by a press-fitting unit having a vertically movable press blade, including the steps of:

disposing in parallel a plurality of connectors having the press-fit-type terminal on a connector retaining bar;

press-fitting the stripped end of the wire to the press-fit-type terminal of the connector by the press-fitting unit;

horizontally transferring the connector retaining bar or the press-fitting unit;

press-fitting one stripped end of another wire to a press-fit terminal of another connector; and

repeating sequentially the horizontally transferring step and the press-fitting step, which accomplishing a wiring harness subassembly mounted on the connector retaining bar. Further, the press-fitting step may be carried out with the stripped end of the wire having been cut in a desired length and having being held by a wire chuck at one end thereof.

Moreover, the invention provides a press-fitting unit including:

a vertically movable press blade for press-fitting an electrical wire to a press-fit-type terminal of a connector; and

an upwardly resiliently loaded wire chuck disposed so as to abut against a rear part of the press blade so that the chuck can unitedly move with the press blade.

The wire chuck may be horizontally movable along a horizontal guide and can horizontally move to a side of the press blade with holding the wire. A couple of the horizontal guides advantageously extend in parallel respectively at each side of the press blade; and the wire chuck can move on the couple of horizontal guides.

Further, the press-fitting unit effectively includes a pair of wire guides each disposed along each side of the press blade and spring-loaded toward the connector, a fore end of each of the wire guides being positioned at each side of the press-fit-type terminal disposed in the connector.

Additionally, this invention provides a connector retaining bar, which includes a longitudinally extending base plate provided with a plurality of connector receiving recesses in parallel, each of the connector receiving recesses being able to hold a connector with a press-fit-type terminal. A plurality of parallel connector supports may be disposed on and held by the base plate, the connector supports respectively having one of the connector receiving recesses.

This invention further provides a press-fitting apparatus having:

a press-fitting unit including a vertically movable press blade for press-fitting an electrical wire to a terminal disposed in a connector,

a frame for fixing the press-fitting unit to the apparatus, a connector retaining bar disposed opposite to the press blade and movable in a horizontal direction, and

a transfer mechanism for transferring the bar,

wherein the connector retaining bar is provided with a plurality of connector receiving recesses in parallel.

Alternatively, the connector retaining bar may be fixed to the apparatus by a frame while and a transfer mechanism for transfers the press-fitting unit along the bar in a horizontal direction.

In addition, the apparatus has a pair or two pairs of upper and lower symmetrical press-fitting units; and the connector retaining bar is disposed between the upper and lower press-fitting units. The press-fitting units may respectively include an upwardly loaded wire chuck disposed so as to abut against a member jointed to the press blade.

Further, the apparatus can press-fit electrical wires to a couple of double-sided terminals mounted in a relative connector. Advantageously, while one side of the connector having double-sided terminal has been supported by the opposing wire guide, the wire is press-fitted into the other side terminal.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a block diagram of a manufacturing method of a wiring harness according to the invention;

FIG. **2** is a perspective view showing generally a press-fitting apparatus utilized in the wiring harness manufacturing method;

FIG. **3** is a perspective view showing a wiring harness subassembly having both a press-fitting terminal and a crimping one;

FIG. **4** is a perspective view showing a stage for fabricating wiring harness subassemblies by utilizing a connector retaining bar;

FIG. **5** is a perspective view showing several groups of wiring harness subassemblies set on a respective connector retaining bar;

FIG. **6** is a top view of the connector retaining bar;

FIG. **7** is the partially omitted front view of the connector retaining bar;

FIG. **8** is a side view showing a press-fitting unit according to the invention;

FIG. **9** is the front view of the press-fitting unit;

FIGS. **10**A to **10**C are explanatory views mainly showing action of a wire guide;

FIG. **11** is the front view showing a first embodiment of a press-fitting apparatus;

FIG. **12** is a top view of the first embodiment;

FIG. **13** is a side view of the first embodiment;

FIG. **14** is the front view showing a second embodiment of the press-fitting apparatus;

FIG. **15** is a top view of the second embodiment;

FIG. **16** is the front view showing a third an embodiment of the press-fitting apparatus;

FIG. **17** is a top view of the third embodiment;

FIG. **18** is a block diagram showing a known crimping-type wiring harness manufacturing method;

FIG. **19** is a top view showing a wire having been stripped at each end thereof;

FIG. **20** is a perspective view showing the wire having been crimped to a terminal;

FIG. **21** is a perspective view showing the wires with the terminals, particularly illustrating a step of striking the wire into a wire holding bar;

FIG. **22** is a perspective view showing a step of inserting the crimped terminal to a connector housing;

FIG. **23** is a block diagram showing a known press-fit-type wiring harness manufacturing method; and

FIG. **24** is a perspective view showing a known step of press-fitting a wire to a connector.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the accompanied drawings, a specified embodiment of the invention will be discussed in detail hereinafter.

FIGS. **1** to **5** shows an embodiment a manufacturing method of a wiring harness according to the invention.

The manufacturing method, as shown in FIG. **1**, a fabricating stage including both a press-fitting step and a crimping step, utilizing a connector **11** with press-fit terminals **10** (FIG. **3**) and a connector **13** with crimp terminals **12** to produce a wiring harness.

Referring to FIG. **1**, based on a production control system **1**, a cutting stage **2** cuts a wire into a desired length by means of a cutter. Stage **3** strips off an insulation at one end of the wire and stage **4** crimps the stripped end of a conductor to a crimp terminal **12** (FIG. **3**). Stage **5** lines up the wires on every type of them for smooth handling and then the wires are delivered along a line A to stage **6** for press-fitting the other end of the wire to the press-fit terminal **10** of the connector **11** (FIG. **3**) by the press-fitting unit. Housing stage **7** inserts the crimp terminal **12** into a terminal receiving chamber of a connector housing **13**.

Further, in the case of press-fitting **6** both the ends of the wire having been cut in the stage **2** in FIG. **1** to a press-fit terminal type connector, a wiring harness subassembly **8** is accomplished without the stage **7** for fitting a case. Meanwhile, in the case of stripping **3** and crimping **4** both the ends of the wire to the terminals **12**, the case fitting stage **7** inserts both the ends of the wire respectively to a connector housing as proceeded along a line C without the stage **6**. Wiring harness subassemblies **8** having completed the casing stage **7** and the press-fitting **6** composes a set of subassemblies for each wiring harness.

Besides, the wire cutting step **2** may be provided separately for the press-fitting stage and for the crimping stage. In that, the stripping stage **3** and the crimping stage **4** are the same as conventional ones produced in a lot.

FIG. **2** shows an apparatus for cutting and press-fitting electrical wires. The wire **14** passes through selective nozzles **15** and is fed by a desired length by a measuring roller **16**. Then, a cutter **17** cuts the wire and a U-turn device (not shown) and a chuck **18** for striking-in provisionally holds the wire bent in a U-shape in a clip **20** mounted on a conveyer belt **19**.

A worker picks up the wire **14** from the conveyor belt **19** and moves it on a pair of wire chucks **22** (22_1,22_2) of a press-fitting apparatus **21**. The wire chucks (wire setting blocks) **22** located on a base frame **23** and formed with a pair of fore and aft, wire supporting channels **24**.

Above the chucks **22** there is mounted a press-fitting unit **25'**. The press-fitting unit **25'**, as described after, is fixed on the frame **23**. Under the press-fitting unit **25'** there is disposed a connector retaining bar **26** horizontally moved along a couple of guide bars **29** by a motor **27** and a ball-screw threaded rod **28**. The connector retaining bar **26** has a plurality of several types of press-fit terminal type connectors **11** detachably disposed in parallel thereon.

The press-fitting unit **25'** has a vertically movable press blade **32** with each end of the wire **14** having been held by the chuck **22**, the downward movement of the press blade **32** press-fits an end **14***a* of the wire **14** at one **221** of the chucks

to a press-fit terminal **10** (FIG. **3**) arranged in the press-fit connector **11**. The chuck **22** can be moved in a horizontal direction (the longitudinal direction of the ~~connector bar~~) by a transfer mechanism (not shown). After the end **14***a* of the wire **14** has been connected to the connector **11**, the other chuck **222** comes just under the press blade **32**. At the same time, the connector retaining bar **26** moves horizontally so that the press blade **32** press-fits the other end **14***b* of the wire **14** a press-fit terminal disposed in the same connector **11** or in an adjacent another connector. Besides, the chuck **22** may have wire handling means (not shown) for elevating and longitudinally transferring the wire.

The wire **14** having been press-fitted in the press-fit type connectors **11** mounted on the connector retaining bar **26**, as shown in FIG. **4**, is crimped at the other end, the end being capped by a case (a connector housing **13**). Finally, all the wires disposed on the single connector retaining bar **26** composes a wiring harness subassembly **34**. Then, as shown in FIG. **5**, a plurality of the connector retaining bars **26** are laid on a carrier **33** in parallel, composing a group **35** of the subassemblies.

FIGS. **6** and **7** shows an example of the connector retaining bar in retail.

The connector retaining bar **26** is composed of an aluminum base plate **36** and a plurality of aluminum connector supports **38**. The supports **38** are fixed in parallel to the base plate **36** with bolts **37**. The base plate **36** has each side wall **40** with an outwardly projecting tab **39**, the side walls **40**, **40** being jointed with a longitudinal bar **41**. The longitudinal bar **41** is formed with recesses **42** at its front side, the recess **42** being secured to the connector support **38** with bolts. Thereby, the connector support **38** is received in a space **43** surrounded by each side wall **40** of the longitudinal bar **41**. Each tab **39** is received in a recess **45** formed in a frame **44** on the press-fitting apparatus **21** (FIG. **2**) and is secured with a spring-loaded pin **46**. Pulling out the pin **46** against the spring force releases the connector retaining bar **26** from the press-fitting apparatus **21**.

The plurality of connector supports **36** respectively have a receiving recess **47** corresponding to an external form of on e of various types of the press-fit connectors **11** so that the recess **47** can receive the relative press-fit connector **11**. A support 38_1 having a receiving, vertically through recess 47_1 corresponds to the double-sided, press-fit type connector **11** shown in FIG. **24**. Meanwhile, a support 38_2 having a receiving recess 47_2 with a bottom corresponds to a single-sided, press-fit type connector **11**. The double-sided connector **11**, as described later, corresponds to a press-fitting apparatus symmetrically disposed a couple of upper and lower press-fitting units **25**. Preparing various types of the ~~connector retaining bars~~ **26** allows to fabricate various types of ~~wiring harness subassemblies~~.

FIGS. **8** and **9** show the press-fitting unit **25** in detail.

This fitting unit **25** includes applicators **48** (FIG. **8**) radially extending from a rotation axis **49** and having a press blade **32** corresponding to one of various types of wires in diameter. A servo-motor **50** turns the rotation axis **49** by way of a timing belt **51**, thereby allowing selection of the applicators **48**.

The applicator **48** includes a slider **52** having a press blade **32** fixed thereto. A shank **53** fixed on an upper end of the slider **52** engages with a hook **55** formed in another upper slider **54**. The upper slider **54** joints to a crank mechanism **56** positioned above the slider **54** and driven by a motor **57** so as to move vertically. Besides, denoted **58** is a flywheel; **59** a connection pin; and **60** a connecting rod. The slider **52** is correctly positioned and provisionally jointed to the applicator **48** by a spring-loaded-ball-type plunger **61**. Further, the downward movement of the slider **54** can releases the slider **52** from the provisional jointing to move downwardly.

Referring to FIG. **9**, in each side of the press blade **32** are disposed a pair of wire slidable guides **62**. The wire guide **62** is slidably, vertically movably supported by the slider **52** with a coil spring **63** therebetween. As is illustrated in FIG. **8**, in front of the press blade **32** is disposed, clamped by a wire chuck **30** opposite thereto. This allows an end of the wire **14**, clamped by a pair of chuck hooks **64**, to be pushed into a press-fit terminal in a connector **11** for press-fit connection as shown in FIGS. **10A** to **10C**.

That is, the wire end **14** clamped by the chuck hooks **64**, as shown in FIG. **10A**, is located between the pair of wire guides **62**. The downward movement of the slider **52** causes a leading end **62***a* of each of the guides **62** to abut against an upper end of a partition **65** for receiving a press-fit terminal in the connector **11**. As shown in FIG. **10B**, downwardly moving the press blade **32** allows the wire **14** to be delivered onto the press-fit terminal **10** along the guides **62**. Finally, the wire can press-fit to the terminal **10** as shown in FIG. **10C**.

In the case of double-sided press-fit-type connector **11** (FIG. **24**), a pair of wire guides (the same ones as illustrated in FIG. **10**) of a lower press-fitting unit 25_2 (FIG. **11**) can abut against partitions **65** of a lower terminal receiving chamber in the connector **11**. This allows the press-fit connector **11** to be supported by the lower unit 25_2. With the supporting condition, an upper press fitting unit **25**i (FIG. **11**) press-fits a wire **14** to a press-fit terminal FIG. **10** disposed in a terminal chamber as described above. The wire guides **62** with the coil spring **63** (FIG. **9**) having been compressed to the maximum abuts against the partition **65** to the press-fit-terminal-type connector **11**. When the press-fit terminal **10** received in the lower terminal chamber press-fits a wire **14**, similarly, the upper wire guides **62** have abutted against the relative partitions **65** of the connector **11**. The coil spring **63** have been compressed to the maximum. This prevents deformation of the connector **11** so that the wire **14** can be reliably press-fitted to the press-fit terminal **10**.

In FIG. **8**, denoted **66** is a switch for detecting the presence of a wire, the switch-on condition allowing the motor **57** to rotate. Regarding the wire chuck **30**, an upper end face **68***a* (an abutting face) of a chuck activating cylinder **65** abuts against a relative abutting block **67** of the slider **54**, and after the abutment, the wire chuck **30** moves downward together with the slider **52**. A distance L between the abutting block **67** and the upper end face **68***a* of the cylinder **68** is the same as a distance between the wire **14** and the blade **32**. The chuck **30** having released from the block **67** can lift along the upward movement of the slider **52**, because the chuck **30** has resiliently jointed to the slider **52** by way of a coil spring **72**. The chuck **30** comprises the chuck the cylinder **68** for opening and closing a pair of chuck hooks **64**, a spring holder **69** unitedly jointed to the chuck the cylinder **68**, a vertical guide **70** for slidably elevating the chuck the cylinder **68**, a chuck the stay **71** including the guide **70** and extending upward, the coil spring **72** compressed and attached between a lower part **71***a* of the stay **71** and the spring holder **69** so as to lift the chuck the cylinder **68** up to the highest position.

The chuck stay **71** is secured to a horizontal the slider **73** (a rod-less cylinder) **73**. The slider **73**, as shown in FIG. **9**, is horizontally movable along a couple of horizontal guide

the bars **75** fixed on a fore side frame **74** of the press fitting unit **25**. There are provided a couple of left and right wire chucks **30**, each having the chuck the stay **71** unitedly fixed to the horizontal slider **73**.

While one chuck 30_1 stays in the middle of the guide the bar **75** so as to align with the press blade **32**, the other chuck **302** is at one end of the guide bar **75**, allowing a worker to supply or receive the wire **14**.

FIGS. **11** to **13** show one example **21** (a first embodiment) of a press-fitting apparatus utilizing the aforementioned press-fitting unit **25**.

A couple of press-fitting units **25** are fixed on the base plate **76** (FIG. **13**) in the middle of a base frame **23**, each of the units being symmetrically disposed above and under the base plate **76**. The base plate **76** is fixed to the base frame **23** by way of support pillars **77**. Between the upper and lower press-fitting units **251**, **252** is disposed the connector retaining bar **26** movable in a longitudinal direction of the frame.

That is, the connector retaining bar **26** is removably attached fixed on a fore part of a movable quadrangular frame **78** (FIGS. **11** to **13**) by a spring-loaded pin **46**. The movable frame **78** has a rear vertical wall **79** fitted with a slide guide **80** (FIG. **12**). The slide guide **80** slidably engage with a horizontal guide bar **29**. Further, the vertical wall **79** fixed with a driven block (a nut) **81** engaging with a rolled thread rod **28** that connects to the servo-motor **27**. These transfer mechanisms **27**, **28**, and **29** can move the frame **78** unitedly with the connector retaining bar **26**.

The press-fitting unit **25** is located in a space **85** inside the movable rectangular frame **78**. The servo-motor **27** is fixed on support pillars **82** fitted on the base frame **23**. A side wail **83** of t he base frame **23** axially rotationally supports an end of the threaded rod **28** and also holds each end of the guide bar **29**. As shown in FIG. **12**, the press-fitting unit **25** has several types of selective, radially extending applicators **48**.

As shown in FIG. **13**, in front of the connector retaining bar **26** there is arranged a cover **84** preventing twine of the wire **14** during transferring of the connector retaining bar.

Thence, horizontally transferring the connector retaining bar **26** allows a desired connector **11** held by the bar to be positioned just under the press-fitting unit **25**. Thereby, the press blade **32** can press-fit the wire **14** to the desired press-fit terminal **10**. Selection method of the connectors **11** is determined by data preliminarily imputed in a control section (not shown).

In this embodiment, the arrangement of the press-fitting units 25_1, 25_2 positioned respectively above and under the connector retaining bar **26** allows the wire **14** to be efficiently automatically press-fitted to the upper and lower terminals **10** disposed in the double-sided connector **11** (FIG. **24**).

FIGS. **14** and **15** shows a second embodiment of the press-fitting apparatus.

This press-fitting apparatus **86** includes two pairs (four units) of the upper and lower press-fitting units **87** related to the connector retaining bar **26**. The press-fitting units 87^1 to 87_4 do not have the above-mentioned pair of the slidable wire chucks 30_1 30_2 but respectively have a wire chuck **30** fixed to a respective unit. The wire chuck **30** is arranged in the middle of the crimping unit **87**, that is, in front of the press blade **32** (FIG. **8**).

Except the above-mentioned mechanism, the second embodiment is the same as the first one. Each of the press-fitting units **87** is fixed to the frame **23**. The movable frame **78** mounted with the connector retaining bar **26** longitudinally moves forward and backward along the base frame by means of the transfer mechanism composed of the motor **27**, the threaded rod **28**, and the guide the bar **29**.

In the embodiment, for example, one 87_1 of the upper crimping units has been press-fitting a wire to a connector **11**, the wire chuck **30** of the other press-fitting unit 87_3 can receive another wire from a setting rack (not shown). This allows the absence of the horizontally sliding unit **74** (FIG. **9**) of the chuck that requires high accuracy in positioning.

FIGS. **16** and **17** shows a third embodiment of the press-fitting apparatus.

This press-fitting apparatus **88** includes a connector retaining bar **26** fixed to a frame **89**. A press-fitting unit **87** is horizontally movable along the frame **89** to the stationary connector retaining bar **26**.

The over all length of the frame **89** is approximately a half of those of the two previously described embodiments. The connector retaining bar **26** extends from one end of the frame **89** to the other end thereof. In a space **90** between the connector retaining bar **26** and the other end of the frame there have been arranged two pairs of upper or lower press-fitting units 87_1 to 87_4. Each of the press-fitting units **87** is secured unitedly to a common base plate **91**. The base plate **91** has a slide guide **92** engaging with a guide bar **93** and has a driven member (a nut) **94** engaging to a ball-screw threaded rod **95**. The threaded rod **95** has jointed to a servo-motor **96**.

As the press-fitting unit **87** moves horizontally, wire chucks may be better mounted around the connector retaining bar (in the fixed the frame). In the middle of the press-fitting units **87** there may be arranged a wire chuck **30** in the same way as the second embodiment. Two pairs of upper and lower press-fitting units **87** may be provided as described in the first an embodiment. The short over all length of the frame **89** that is only a little longer than the connector retaining bar **26** allows the press-fitting apparatus to be minimized in size.

Operational effects of the invention will be discussed hereinafter.

As mentioned above, the manufacturing method of the wiring harness according to the invention can give a wiring harness including both crimped terminals and press-fitted terminals. Thereby, connectors with press-fit terminals popular in recent years and conventional connectors with crimped terminals can coexist in their application.

Further, in the manufacturing method of the wiring harness utilizing the connector retaining bar and the press-fitting apparatus, the step of press-fitting the wire to the press-fit-terminal-type connector can accomplish plural jobs. The plural jobs include striking the other end of the wire having a crimped terminal into a clip mounted on a wire holding beam, removing the wire from the clip, and inserting the crimp terminal into the connector housing. Further, after completion of the press-fitting, wiring harness subassemblies on every connector retaining bar are supplied, which greatly improves the producing process of the wiring harness in efficiency, workability, and productivity.

Moreover, the press-fitting unit can reliably press-fit an end of the wire to the relative terminal with the wire having been held by the wire chuck. In the press-fitting unit, while one of the wire chucks has held a wire for press-fitting, the other wire chuck can receive a next wire. This causes an improved efficiency in production. Further, in the press-fitting unit, the wire advances along the guide into the press-fit-type terminal, allowing positive press-fitting to improve connection in reliability.

Moreover, in the press-fitting apparatus shown in FIGS. 11 to 13, the wire chuck of the crimping unit can catch a wire during the horizontal movement of the connector retaining bar, which improving productivity of the fabrication. In the press-fitting apparatus shown in FIGS. 14 to 17, the fitting unit trips round along the connector retaining bar, which enabling a smaller system than the one having a transferring connector retaining bar. Selectively, the press-fitting apparatus can press-fit wires to each side of a double-sided, press-fit-terminal-type connector. The arrangements shown in FIGS. 10A to 10C prevent deformation of the connector housing during the press-fitting operation of the received terminals, allowing reliable work thereof.

What is claimed is:

1. A press-fitting apparatus arranged to manufacture a wire harness, comprising:

a press-fitting unit having a vertically movable press blade for press-fitting an electrical wire to a terminal disposed in a connector,

a frame for fixing said press-fitting unit to said apparatus,

a connector retaining bar mounted opposite to said press blade, and

a transfer mechanism for transferring said bar in a horizontal direction,

wherein said connector retaining bar has a base plate and a plurality of parallel connector supports, the connector supports having a plurality of connector receiving recesses corresponding to an external form of one of various press-fit connectors, and said connector retaining bar is provided with said plurality of connector receiving recesses disposed along said connector retaining bar, each said connector receiving recess formed separate from others and shaped to engage with a connector, said connector retaining bar arranged to prepare a set of subassembled wire harnesses having different types of connectors.

2. The apparatus as claimed in claim 1, wherein the apparatus has a pair or two pairs of said press-fitting units, the pair being symmetrically disposed to each other; and said connector retaining bar is mounted between said pair of symmetrical press-fitting units.

3. The apparatus as claimed in claim 2, wherein said press-fitting unit has the vertically movable press blade for press-fitting an electrical wire to the terminal of the connector, and an upwardly resiliently loaded wire chuck disposed opposite to and in front of said press blade, said chuck being able to abut against a member jointed to said press blade so that said chuck can unitedly move with said press blade.

4. The apparatus as claimed in claim 1, wherein said apparatus has a pair or two pairs of upper and lower symmetrical press-fitting units; and said connector retaining bar is disposed between said upper and lower press-fitting units; and said press-fitting unit can press-fit electrical wires to a couple of terminals mounted in a double-sided-terminal connector.

5. The apparatus as claimed in claim 2, wherein said apparatus has the pair or two pairs are upper and lower symmetrical press-fitting units; said connector retaining bar is disposed between said upper and lower press-fitting units; and said press-fitting unit can press-fit electrical wires to a couple of terminals mounted in a double-sided-terminal connector.

6. A press-fitting apparatus arranged to manufacture a wire harness, comprising:

a press-fitting unit including a vertically movable press blade for press-fitting an electrical wire to a terminal disposed in a connector,

a connector retaining bar fixed to the apparatus by a frame, and

a transfer mechanism for transferring said press-fitting unit along said bar in a horizontal direction,

wherein said connector retaining bar has a base plate and a plurality of parallel connector supports, the connector supports having a plurality of connector receiving recesses corresponding to an external form of one of various press-fit connectors, and said connector retaining bar is provided with said plurality of connector receiving recesses disposed along said connector retaining bar, each said connector receiving recess formed separate from others and shaped to engage with a connector, said connector retaining bar arranged to prepare a set of subassembled wire harnesses having different types of connectors.

7. The apparatus as claimed in claim 6, wherein said press-fitting unit has a vertically movable press blade for press-fitting an electrical wire to a press-fit terminal of a connector, and an upwardly resiliently loaded wire chuck disposed opposite to and in front of the said press blade, said chuck being able to abut against a member jointed to said press blade so that said chuck can unitedly move with said press blade.

8. The apparatus as claimed in claim 7, wherein the apparatus has a pair or two pairs of said press-fitting units, the pair being symmetrically disposed to each other; and said connector retaining bar is mounted between said pair of symmetrical press-fitting units.

* * * * *

United States Patent [19]

Fukuda et al.

[11] **Patent Number: 5,052,449**

[45] **Date of Patent: Oct. 1, 1991**

[54] **AUTOMATIC WIRE PRESS-CONNECTING AND LAYING OUT APPARATUS FOR WIRE HARNESS**

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[52] **U.S. Cl.** ..... **149/93 R**; 29/755

[58] **Field of Search** ..... 29/564.8, 747, 748, 29/755, 850, 857; 140/92.1, 93 R

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Primary Examiner—Lowell A. Larson
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[57] **ABSTRACT**

An automatic wire press-connecting and laying out apparatus for a wire harness has, as its main portion, a wire press-connecting and laying out portion, comprising a wire feed portion having a wire feeding mechanism for individually feeding out wires and a wire severing mechanism for individually severing wires for feeding out wires, separate cassette lay-out boards detachably and horizontally disposed on a frame table in such a manner as to be opposite to each other via a depression and each having a group of connectors detachably arranged at predetermined positions thereon, and a head portion provided in such a manner as to vertically suspend over the cassette lay-out boards and having a transfer means for enabling the head portion to move to a relative position defined by orthogonal X and Y axis dimensions of the cassette lay-out boards, a wire drawing mechanism for individually drawing wires and a wire press-connecting mechanism comprising a plurality of wire press-connecting portions arranged in parallel. These wire drawing and wire press-connecting mechanisms are provided in such a manner as to face downwardly. A wire dimension adjusting mechanism for adjusting the dimension of individual wires is provided either on the wire feeding mechanism or on the wire drawing mechanism, and the head portion clamps wires protruding from the distal end of the wire feed portion and sequentially distributes the clamped wires to the connectors so as to be press-connected thereto. The wires are individually severed after the dimension of the individual wires has been adjusted, and the wires are laid out in a required configuration with the intermediate portions thereof being allowed to suspend into the depression so as to be received therein.

3 Claims, 11 Drawing Sheets

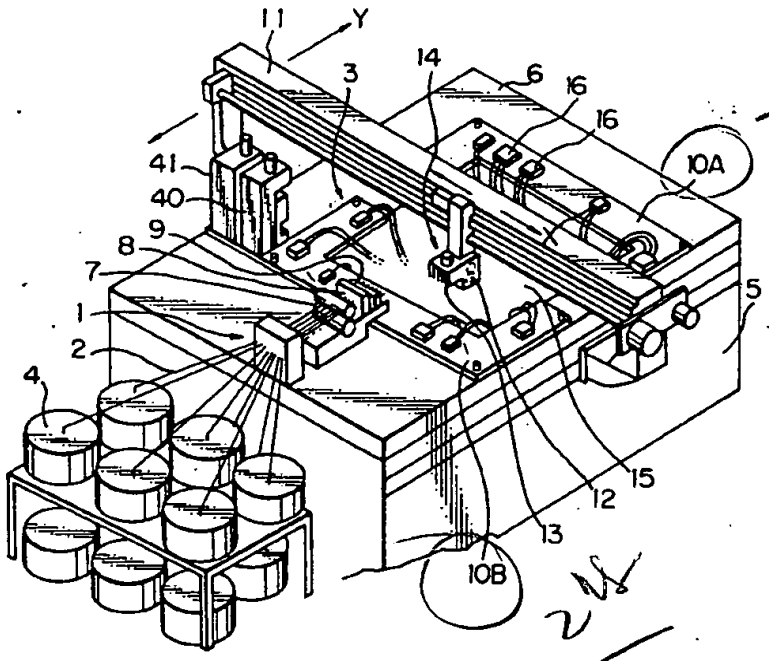


Fig.1(A)

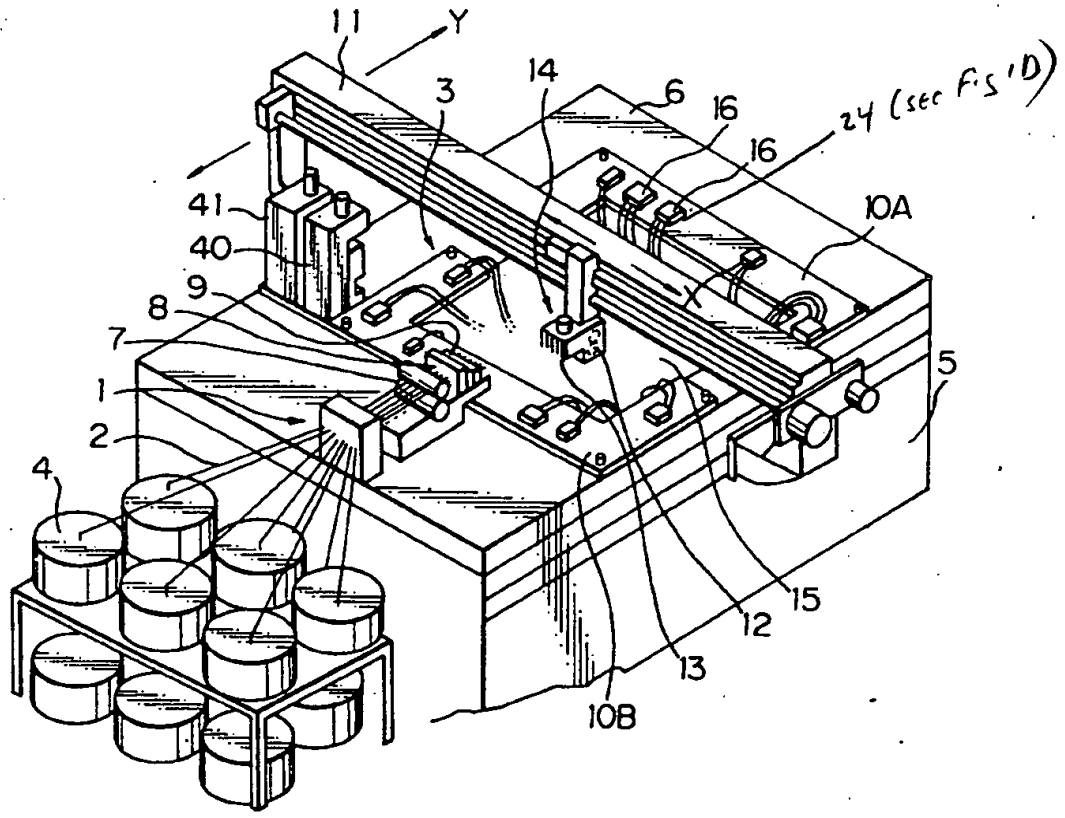


Fig. 1(B)

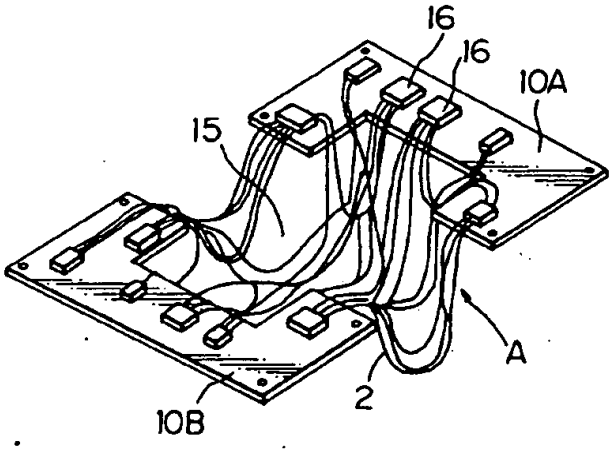


Fig. 1(C)

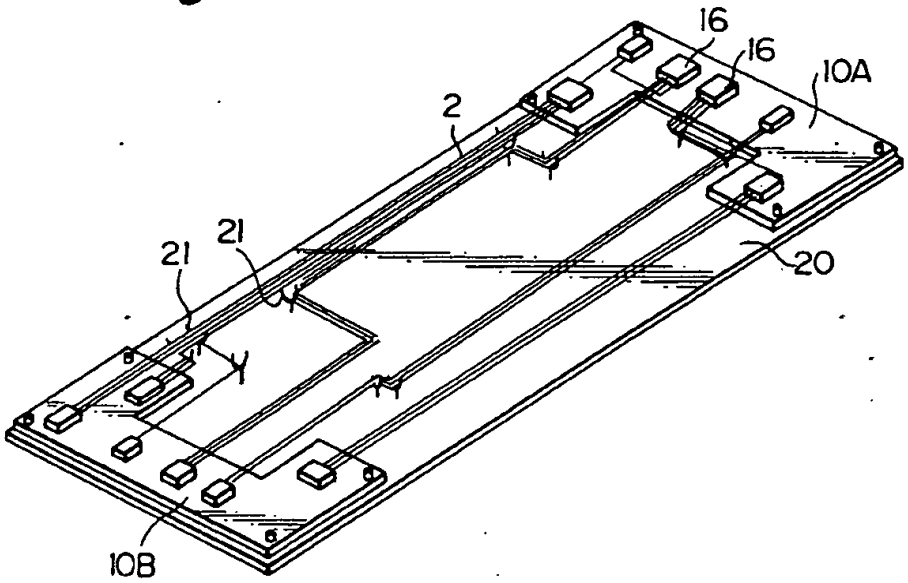


Fig.1(D)

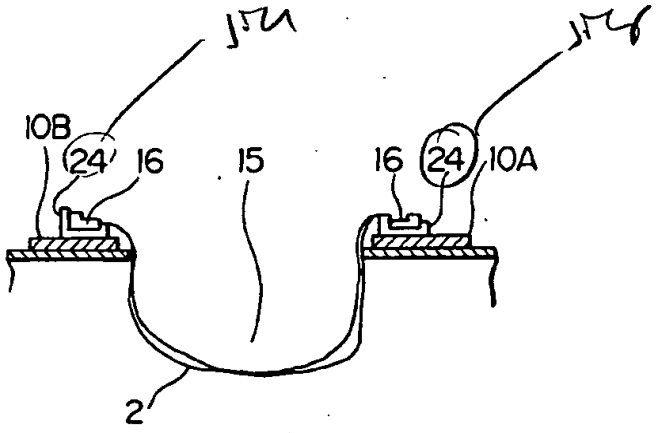


Fig.1(E)

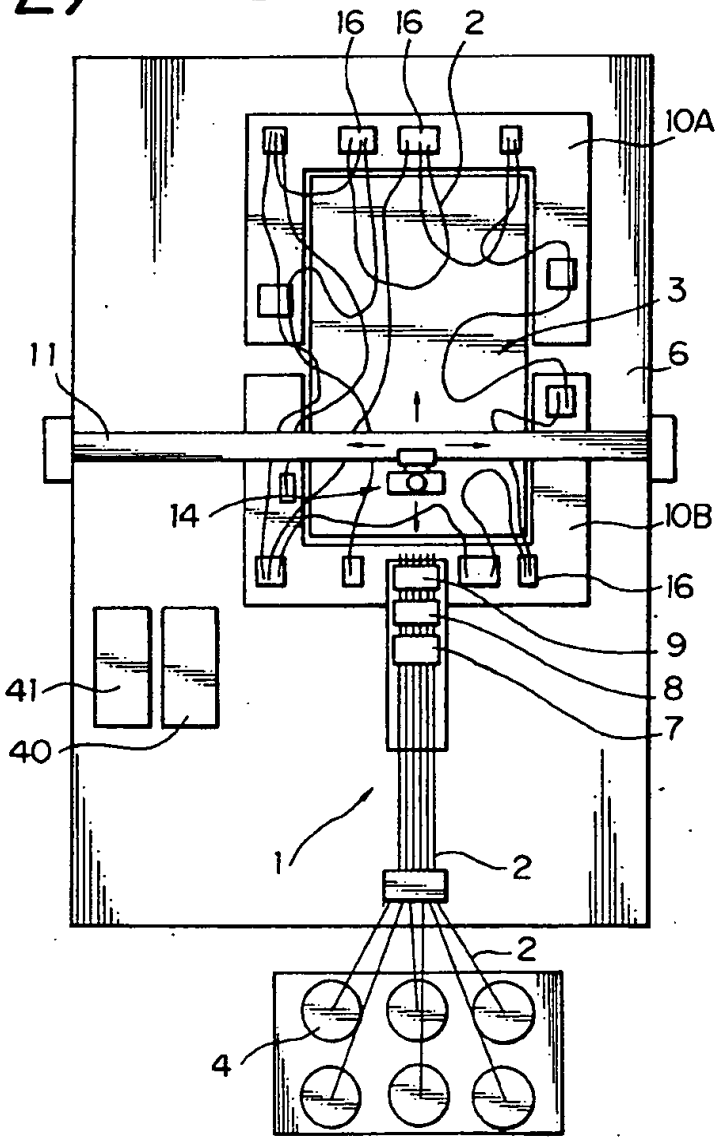
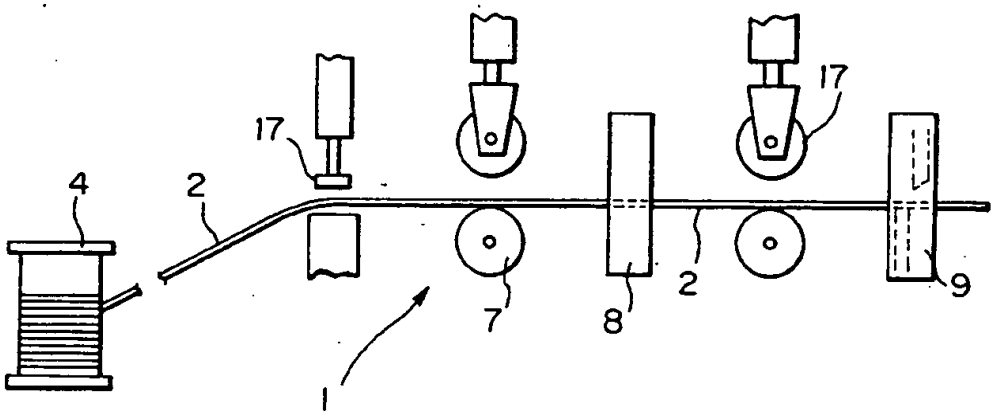


Fig. 2(A)



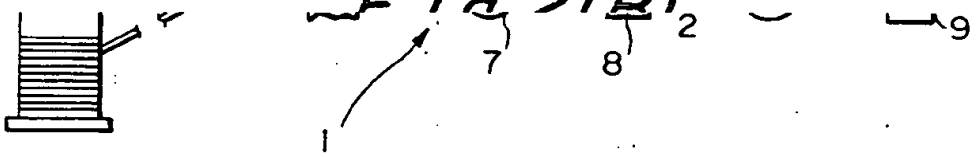


Fig. 2(B)

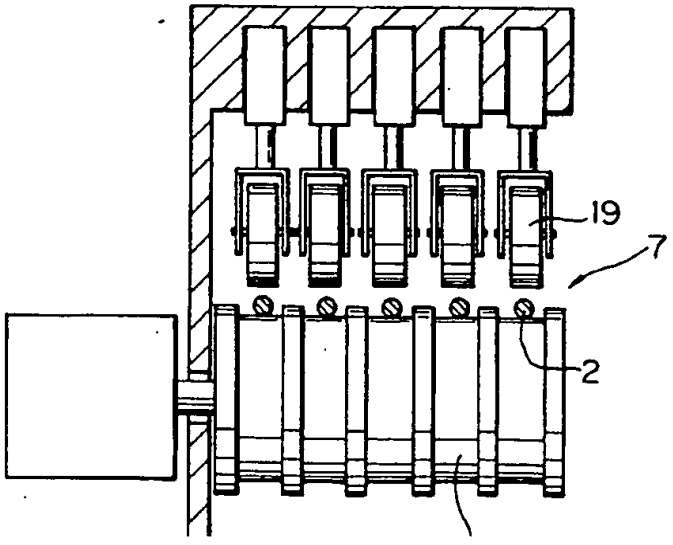


Fig.3(A)

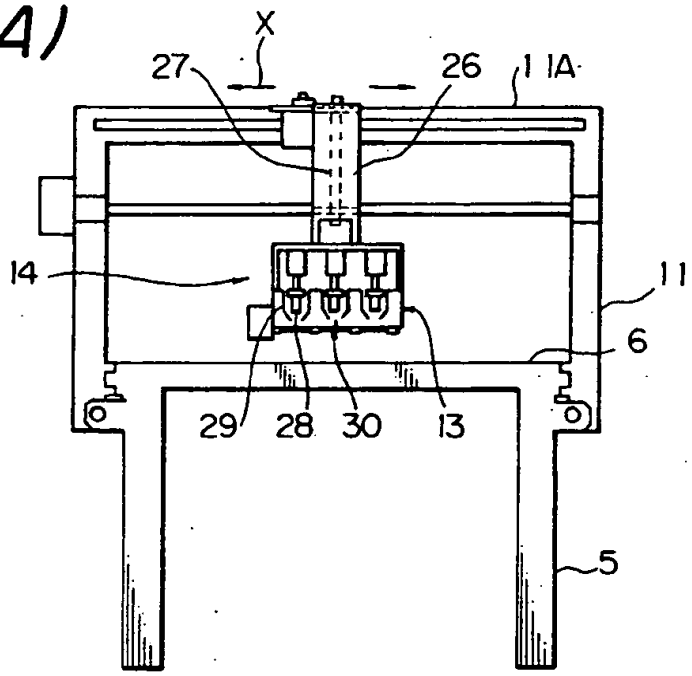


Fig.3(B)

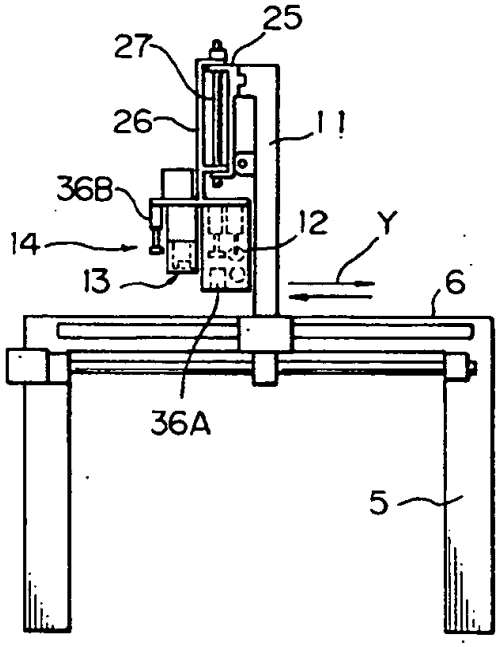


Fig.4(A)

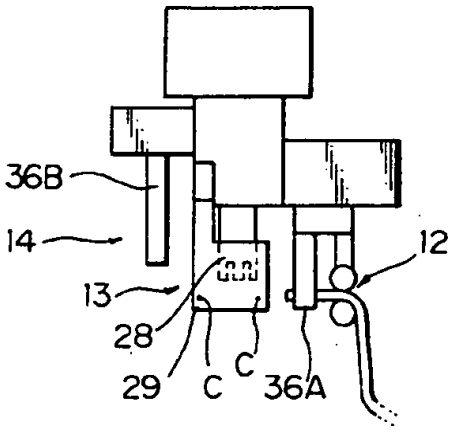


Fig.4(B)

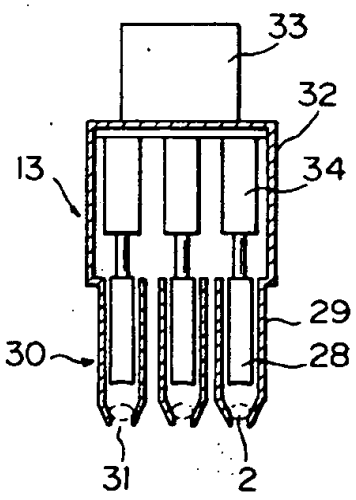


Fig.4(C)

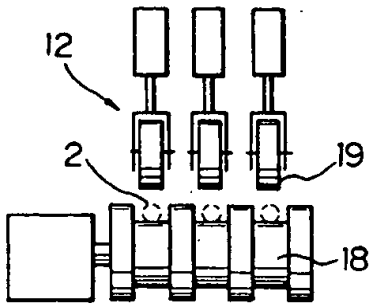


Fig.4(D)

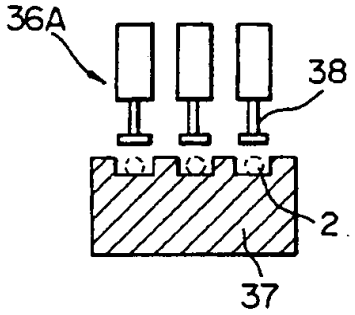


Fig.4(E)

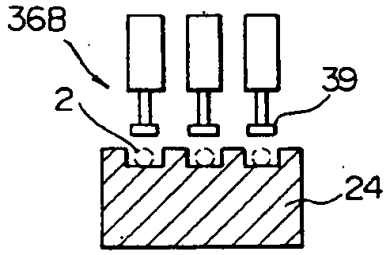


Fig.4(F)

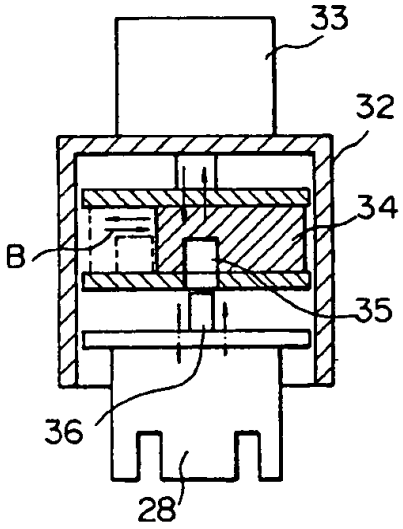


Fig.5(A)

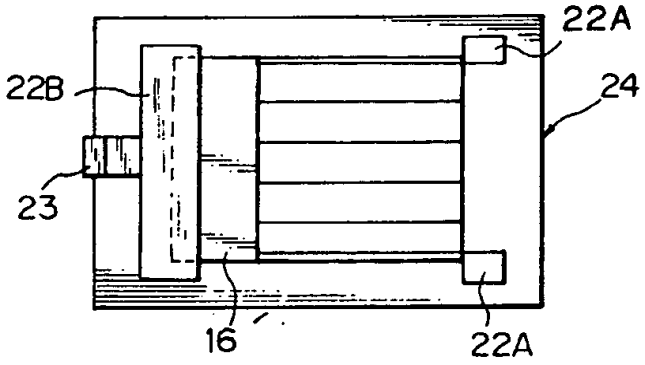


Fig.5(B)

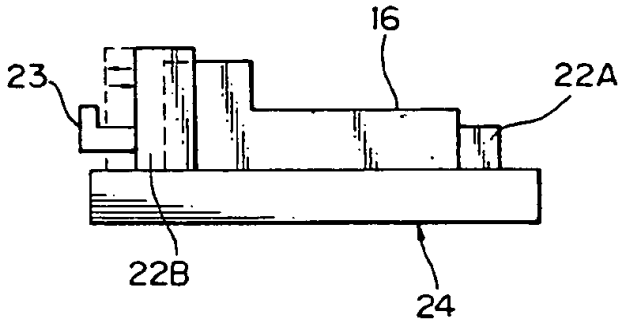


Fig.6(A)

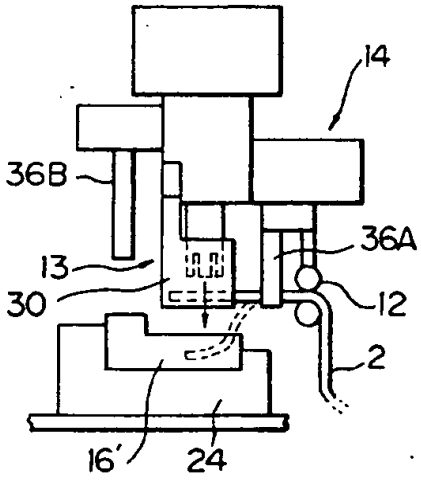


Fig.6(B)

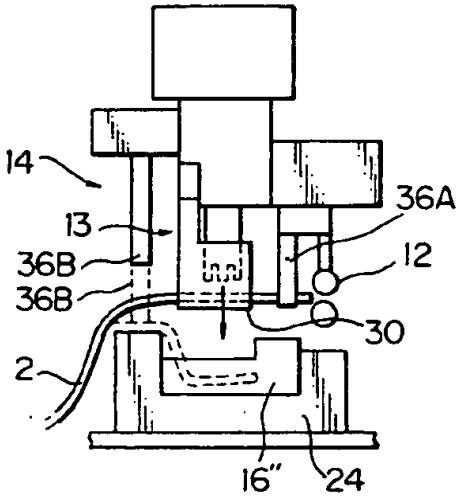


Fig.6(C)

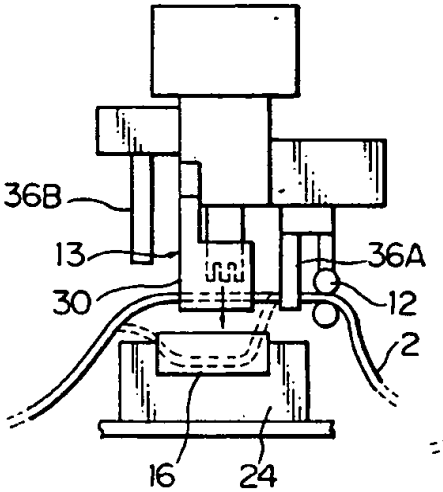


Fig.6(D)

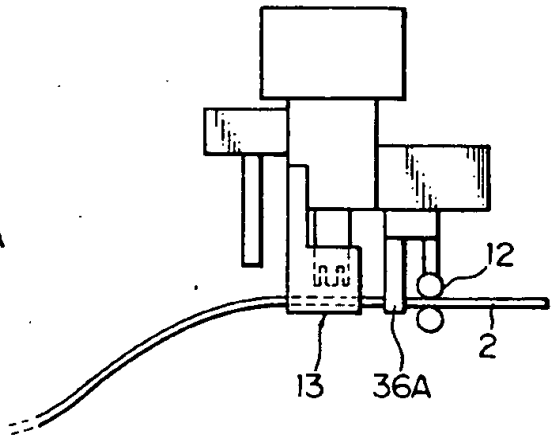


Fig.7(A)

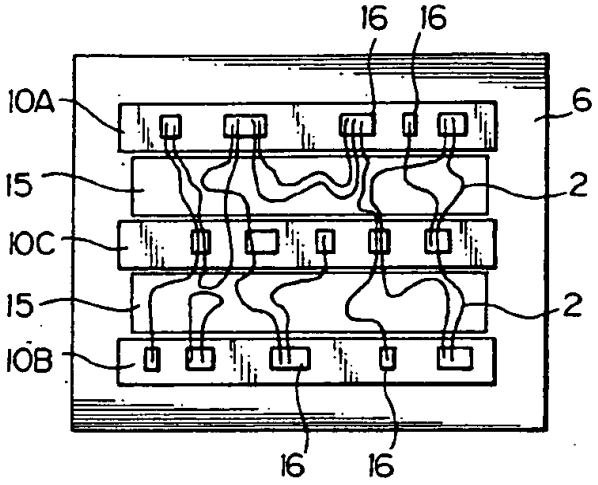


Fig.7(B)

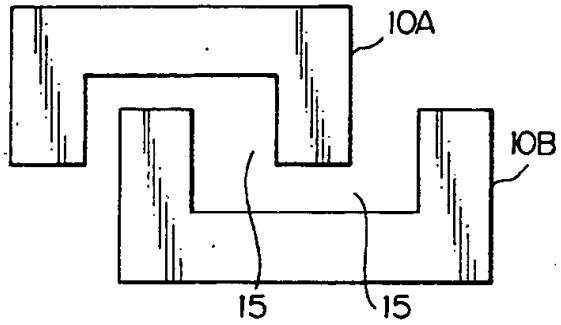


Fig.7(C)

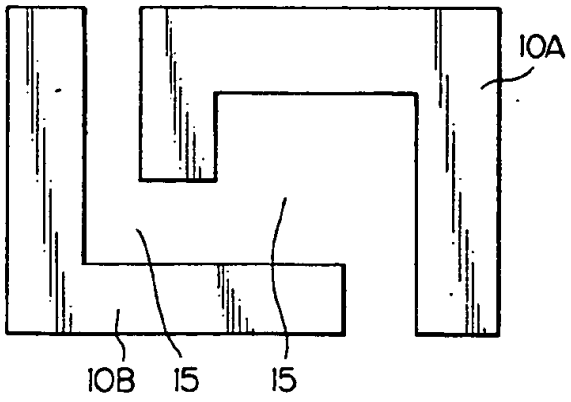


Fig.8(A)

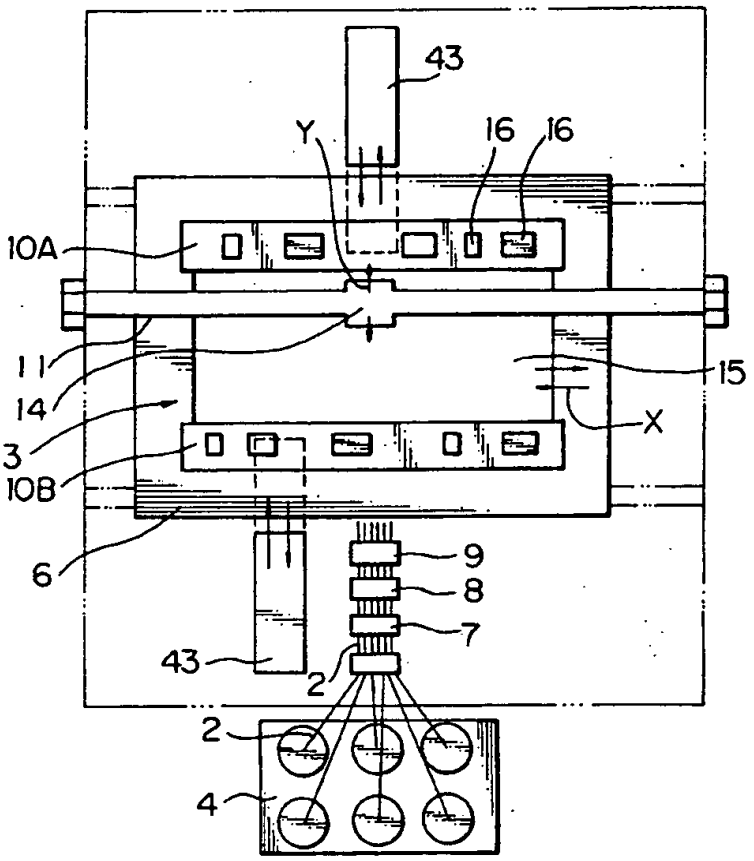
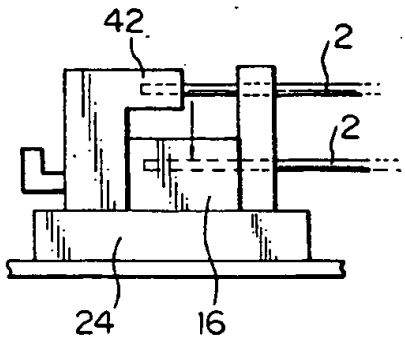


Fig.8(B)



AUTOMATIC WIRE PRESS-CONNECTING AND LAYING OUT APPARATUS FOR WIRE HARNESS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an automatic wire press-connecting and laying out apparatus for use in making a wire harness in which a group of required wires are press-connected and laid out in a required configuration.

2. Statement of the Prior Art

The official gazette of U.S. Pat. No. 3,930,524 discloses a typical example of conventional automatic wire press-connecting and laying out apparatus for a wire harness and a method for manufacturing the same, and the official gazette of Japanese Patent Laid-Open No. 95016/1982 discloses a typical example of automatic apparatus for forming wires having solderless terminals and a method for manufacturing the same.

In the automatic wire press-connecting and laying out apparatus disclosed in the former official gazette of the U.S. patent wire end holders are arranged at predetermined positions on a lay-out board in the actual dimensions of a wire harness to be made, and a wire dispensing head adapted to move in two dimensions along X and Y axes is provided above the lay-out board. This wire dispensing head clamps a wire fed from a wire feed portion and distributes it to predetermined wire end holders on the lay-out board, where the ends of the wire are set to be retained, and the wire is then cut, the wire being thereby laid out in a predetermined configuration. This operation is repeated until a required configuration for the wire harness being made is completed. Afterwards, individual wires so set in wire end holders are press-connected to terminals in a sequential manner. Thus, a group of wires required to make a wire harness are automatically press-connected and laid out in a predetermined configuration.

In contrast, in the automatic apparatus for forming wires having solderless terminals disclosed in the latter official gazette of the Japanese patent the main part of the apparatus comprises a connector feed path for forward feeding a pair of connectors, a plurality of groups of work heads disposed along the length of the connector feed path at suitable intervals, and wire feed portions provided for each of the plurality of work head groups. In this construction, at each position along the connector feed path where a group of work heads are provided a wire to be fitted on a pair of connectors being fed along the feed path is cut to a predetermined dimension, and is press-connected to the pair of connectors at the ends thereof. Thus, at the end of the forward travel along the feed path, the pair of connectors are fitted with a group of required wires having solderless terminals press-connected thereto.

Of these prior art automatic wire press-connecting and laying out apparatuses, the former apparatus has the following drawbacks due to the basic construction thereof in which a lay-out board in the actual dimension of a wire harness to be made is employed and in which wires are press-connected and laid out one by one after they have been cut to predetermined dimensions.

(1) The total travelling distance of the wire dispensing head becomes substantially equal to the total length of wires used. Due to this, the productivity of wire harnesses comprising a number of groups of long wires becomes low, and hence the apparatus is not suitable for mass-production systems.

(2) A lay-out board in actual dimensions is used, and the maximum total length of wires laid out becomes about three meters before such a lay-out board is completed. Due to this, an enormous apparatus is needed, and hence excessively wide space is required to install such as apparatus. Moreover, the number of travelling strokes of the wire dispensing head becomes equal to the number of wires laid out. These facts involves the multiplication of low productivity.

(3) The apparatus disclosed only functions to dispense wires on wire end holders arranged on the lay-out board so as to set the same thereon and many post-stages including that of press-connecting wires so dispensed are left unfulfilled.

The latter automatic apparatus for forming wires having solderless terminals has the following drawbacks due to the construction thereof in which wires are press-connected to a pair of connectors one by one by work heads arranged linearly.

(1) The press-connecting of wires is allowed only between a pair of connectors, and in a case where a wire harness has three or more connectors to which wires have to be press-connected, it has to be disassembled to accomplish this after the press-connecting of wires between any two of those connectors has been completed. Due to this, the types of wire harnesses to be formed with this apparatus are limited.

(2) Only wires having solderless terminals can be formed, and laying out of wires for a wire harness cannot be accomplished. Due to this, there remain a number of post-stages to be accomplished before the formation of a wire harness is completed.

(3) Groups of work heads are linearly arranged, and wire feed portions are required for each group of work heads. Due to this, the apparatus has to be made larger and complex, and hence wide space is needed for the installation thereof. Thus, the apparatus lacks the suitability for an automatic forming apparatus.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a novel automatic wire press-connecting and laying out apparatus for a wire harness that can eliminate the above-mentioned drawbacks inherent in the prior art.

This technical subject is fulfilled by an automatic wire press-connecting and laying out apparatus according to first and second embodiments of the present invention. The main portion of the first embodiment comprises:

a wire feed portion for feeding out a group of wires that has a mechanism for individually feeding out wires and a mechanism for individually severing wires:

separate cassette lay-out boards detachably and horizontally disposed on a frame table in such a manner as to be opposite to each other via a depression and each having a group of connectors detachably disposed at predetermined positions thereon: and

a head portion disposed so as to vertically suspend over the cassette lay-out boards and having a transfer means for enabling transfer to a relative position defined by two dimensions along X and Y axes, and a drawing mechanism for individually drawing wires and a wire press-connecting mechanism comprising a plurality of wire press-connecting portions disposed in parallel, these two mechanisms being made to face downwardly.

A mechanism for individually adjusting the dimension of wires is provided either on the mechanism for individually feeding out wires or on the mechanism for individually drawing wires. In this construction, the ends of a group of wires projecting from the wire feed portion are clamped by the head portion, which distributes the wires to connectors disposed at M end (corresponding to the leading ends of the wires) in a sequential manner with the wires being individually severed to a predetermined dimension. The wires so severed are press-connected to the connectors at M end with the intermediate portions thereof being allowed to suspend into the depression so as to be received therein. Subsequently, the drawing mechanism draws out the intermediate portions of the respective wires from the depression until the other ends of the wires come to the head portion with the intermediate portions thereof again being allowed to suspend in the depression so as to be received therein, and then the head portion transfers and distributes the wires to connectors at N end (corresponding to the rear ends of the wires), where the wires are press-connected to the connectors at the other end thereof thereby making it possible to lay out a group of wires in predetermined configuration with both ends thereof being press-connected to the connectors.

The main portion of the automatic wire press-connecting and laying out apparatus according to the second embodiment of the present invention comprises:

a wire feed portion for feeding out a group of wires that has a mechanism not only for individually adjusting the dimension of wires but also for individually feeding out wires and a mechanism for individually severing wires:

separate cassette lay-out boards detachably and horizontally disposed on a frame table in such a manner as to be opposite to each other via a depression, each having a group of connectors detachably disposed at predetermined positions thereon, and having a transfer means for enabling the transfer thereof in a dimension along the X axis:

a head portion disposed so as to vertically suspend over the cassette lay-out boards and having a transfer means for enabling transfer thereof in a dimension along the Y axis and a drawing mechanism for individually drawing wires at the lower portion thereof: and

wire press-connecting presses disposed on the frame table at positions adjacent to the outer edges of the cassette lay-out boards disposed opposite to each other.

The connectors are detachably mounted on a connector fixing jig having a wire holder for temporarily holding a wire.

In this construction, the ends of a group of wires projecting from the wire feed portion are clamped by the head portion which distributes the wires to the wire holders of the connectors disposed at M end (corresponding to the leading ends of the wires) in a sequential manner with the wires being individually severed to a predetermined dimension. The wires so severed are press-connected to the connectors at M end by means of the wire press-connecting press with the intermediate portions thereof being allowed to suspend into the depression so as to be received therein. Subsequently, the drawing mechanism draws out the intermediate portions of the respective wires from the depression until the other ends of the wires come to the head portion with the intermediate portions thereof again being allowed to suspend in the depression so as to be received therein, and then the head portion transfers and distributes the wires to the wire holders of the connectors at N end (corresponding to the rear ends of the wires) in a sequential manner, where the wires are press-connected to the connectors at the other end thereof by means of the wire press-connecting press, thereby making it possible to lay out a group of wires in predetermined configuration with both ends thereof being press-connected to the connectors.

In the automatic wire press-connecting and laying out apparatus constructed as described above according to the present invention, a plurality of wires are distributed to the groups of connectors arranged on the separate cassette lay-out boards disposed opposite to each other via the depression every travel of the head portion, and the wires so laid out are then press-connected to the associated connectors with the intermediate portions thereof being allowed to suspend into the depression so as to be received therein. Due to this, the total travelling distance of the head portion can be remarkably reduced to "one-twentieth or thirtieth" of the total length of the wires used, and the number of travelling strokes of the head portion can also be reduced to "one half or third" of the number of wires used, the efficiency of wire press-connecting and laying out operations for the formation of a wire harness being thereby improved remarkably. In addition, the press-connecting and laying out of wires are performed on the cassette, lay-out boards disposed close to each other. This serves to make the apparatus smaller in size, and the necessity for enormous space for the laying out of wires can be obviated. Furthermore, the cassette lay-out boards on which wires have been properly press-connected and laid out only have to be transferred to a wire harness forming conveyor or the like, where the cassette lay-out boards are properly spaced at a predetermined span of wires and final work such as completing the configurations of the laid out wires mounting accessory parts and so forth can be carried out, the efficiency of the total wire harness forming operation being thereby improved remarkably.

DESCRIPTION OF THE DRAWINGS

FIG. 1 shows the automatic wire press-connecting and laying out apparatus according to the first embodiment of the present invention, wherein FIG. 1(A) is a perspective view showing the whole of the apparatus. FIG. 1(B) is a perspective view showing cassette lay-out boards on which press-connecting and laying out of wires have been completed, FIG. 1(C) is a perspective view showing a state in which a wire harness is formed. FIG. 1(D) is a sectional view of the main portion-of the apparatus shown in FIG. 1(A), and FIG. 1(E) is a plan view of the apparatus shown in FIG. 1(A);

FIG. 2 shows the wire feed portion of the apparatus shown in FIG. 1(A), wherein FIG. 2(A) is a drawing showing the concept of the construction of the wire feed portion, and FIG. 2(B) is a front view of the mechanism for adjusting the dimension of wires and feeding out wires:

FIG. 3 shows the head portion of the embodiment shown in FIG. 1, wherein FIG. 3(A) is a front view of the head portion, and FIG. 3(B) is a side view of the same:

FIG. 4 shows the main portion of the head portion of the embodiment shown in FIG. 1, wherein FIG. 4(A) is a side view of the main portion, FIG. 4(B) is a front view of the wire press-connecting mechanism of the main portion. FIG. 4(C) is a front-view of the wire

drawing mechanism of the same, FIGS. 4(D), (E) are front views of wire pressing mechanisms of the main portion, and FIG. 4(F) is a side view of a wire press-connecting selection means:

FIG. 5 shows the connector fixing, jig of the embodiment shown in FIG. 1, wherein FIG. 5(A) is a plan view of the jig and FIG. 5(B) is a front view of the same:

FIGS. 6(A), (B), (C) and (D) are side views showing states in which the head portion is in operation, respectively:

FIGS. 7(A), (B) and (C) are plan views of cassette lay-out boards according to the other embodiments of the present invention: and

FIG. 8 shows the automatic wire press-connecting and laying out apparatus according to the second, embodiment of the present invention, wherein FIG. 8(A) is a plan view showing the whole of the apparatus, and FIG. 8(B) is a front view of the connector fixing jig employed therein.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the accompanying drawings, embodiments of the present invention will now be described in detail.

Referring to FIGS. 1 to 6, the automatic wire press-connecting and laying out apparatus according to the first embodiment of the present invention will be described. As shown in FIG. 1, the main portion of the apparatus comprises a wire feed portion 1 for adjusting the dimension of a group of wires 2 and feeding out the same and a wire press-connecting and laying out portion 3 for press-connecting the group of wires 2 so fed to connectors 16. The wire feed portion 1 in turn comprises a wire supply 4 from which various types of wires 2 are drawn out to be supplied in a sequential manner, a mechanism 7 for adjusting the dimension of wires and feeding out the same (hereinafter referred to as "wire dimension adjusting and feeding out mechanism) and a severing mechanism 9. These two mechanisms are provided as a unit on a table 6 of a frame 5.

The wire press-connecting and laying out portion 3 comprises a pair of separate cassette lay-out boards 10A, 10B disposed horizontally on the table 6 on the frame 5 in such a manner as to be opposite to each other via a depression 15 and each having connectors 16 arranged at predetermined positions thereon, and a head portion 14 vertically suspending from a travelling portal frame 11 provided on the frame 5 in such a manner as to travel over the cassette layout boards 10A, 10B in orthogonal dimensions along the X and Y axes, and having a wire drawing mechanism 12 for drawing wires 2 and a wire press-connecting mechanism 13 comprising a plurality of press-connecting portions.

The head portion 14 clamps the leading ends of a group of wires that protrude from the distal end of the wire feed portion 1 in an laterally parallel fashion and moves to distribute them to the connectors 16 arranged at predetermined positions in a sequential manner, and the intermediate portions of the wires 2 are, as shown in FIGS. 1(B), (D), allowed to suspend into the depression 15 so as to be received therein during the movement of the head portion 14. Thus, the wires 2 are laid out in a predetermined configuration for a wire harness being made, and the wires 2 so laid out are press-connected to the connectors 16 at the ends thereof, thereby making it possible to form a wire harness forming unit A in which the wires having solderless connectors are laid out in a required configuration.

To be specific, as shown in FIG. 2, the wire feed portion 1 has downstream of the wire supply 4 in which wires in various sizes are stored in the form of reels or in buckets the wire dimension adjusting and feeding out mechanism 7 for adjusting the dimension of wires 2 aligned in parallel and individually feeding out the same and the severing mechanism 9 for individually severing the wires 2 the dimension of which has been adjusted accordingly. The leading ends of the wires 2 drawn out of the wire supply 4 are caused to protrude from the severing mechanism 9 for transfer to the connectors, and when the leading ends of the wires 2 are fed into the head portion 14, the wire dimension adjusting and feeding out mechanism 7 starts to individually feed out the wires 2 while individually adjusting the dimension thereof, subsequent to which the wires 2 so fed out are individually severed to a predetermined dimension by means of the severing mechanism 9. Afterwards, the wires so severed are fed to the wire press-connecting and laying out portion 3.

The wire dimension adjusting and feeding out mechanism 7 employed in this embodiment comprises, as shown in FIG. 2(B), a rotatable laterally elongate main roller 18 and sub-rollers 19 disposed above the main roller 18 so as to individually clamp and/or unclamp the wires 2 in cooperation with the former and in this construction when the wires 2 are individually clamped between the main and respective sub-rollers, the wires 2 are individually fed out while the dimension of the wires 2 are being individually adjusted. The severing mechanism 9 has severing blades for individual wires and is mechanically interlocked with the wire dimension adjusting and feeding out mechanism 7 so as to sever the wires 2 when the dimension thereof has been adjusted.

In FIG. 2(A), reference numeral 8 denotes a marking portion for applying a numeral or identification color to wires to be fed out with the dimension thereof being adjusted if such is required, and reference numeral 17 denotes a wire clamp for applying a low tension to wires 2 fed through the wire dimension adjusting and feeding out mechanism 7 with a view to improving the dimension adjusting accuracy of the same mechanism.

The cassette lay-out boards 10A, 10B of the wire press-connecting and laying out portion 3 are detachably fixed onto the table 6 via the depression 15 that is deep enough to accommodate the longest wire required for a wire harness to be made when it is allowed to suspend thereinto, and the group of connectors 16 to which M ends (the leading ends) of the wires 2 are press-connected are arranged in a required configuration for a wire harness being made mainly on the lay-out board 10A, while the group of connectors 16 to which N ends (the rear ends) of the wires 2 are press-connected are arranged in a required configuration for a wire harness being made mainly on the lay-out board 10B, These groups of connectors are, as shown in FIG. 5, securely mounted on connector fixing jigs 24 having a one-touch attaching and/or detaching construction in which when an operation piece 23 is pressed down, a locking pawl 22b is biased forward by the action of a spring, thereby holding the connector 16 so as to be fix in position, while when the locking pawl 22b is allowed to withdraw, the connector 16 is then released.

As shown in FIGS. 3 and 4, the head portion 14 of the wire press-connecting and laying out portion 3 is pro-

vided in such a manner as to vertically suspend from a vertical suspending frame 26 mounted on a travelling table 25 adapted to travel in the X axis dimension of the cassette lay-out boards 10A, 10B along an upper beam 11A of the portal frame 11 that is adapted to travel in the Y axis dimension of the cassette lay-out boards 10A, 10B along the sides of the frame 5. In addition, this vertical suspending frame 26 has a rotation mechanism for allowing itself to rotate through 180° about a vertical suspending shaft 27. Thus, the head portion 14 is constructed such that it can freely travel in the X and Y axes over the cassette laying boards 10A, 10B, while it can also freely rotate about the axis of the vertical suspending shaft.

Furthermore, the head portion 14 has the wire press-connecting mechanism 13 and wire drawing mechanism 12, and these mechanisms will be described in detail below. As shown in FIG. 4(B), the wire press-connecting mechanism 13 comprises a wire press-connecting portion 30 comprising in turn a plurality (three in the drawing) of receiving cases 29 arranged in parallel. This receiving case 29 comprises a pair of nail pieces and receives therein a known wire press-connecting blade 28 in such a manner that the blade 28 faces downwardly. In addition, the receiving case 29 is provided with a slit-like resilient opening 31 at the bottom end thereof. A press-connecting blade selection member 34 is provided in a housing 32 above the wire press-connecting portion 30 comprising a plurality of receiving houses 29 arranged in parallel, and an actuator portion 33 is provided above the press-connecting blade selection member 34 to vertically move the same member. Thus, the wire press-connecting mechanism 13 incorporates a press-connecting blade selection mechanism in which of the press-connecting blades 28 installed only selected one or ones is caused to operate.

The press-connecting blade selection member 34 is, as shown in FIG. 4(F), caused to selectively operate in the direction as shown by reference arrow B in the housing 32, and a losing notch 35 is formed in the press-connecting blade selection member 34 in such a manner as to extend from the vertically intermediate portion to the bottom portion thereof. The press-connecting blades 28 needing to operate are forcibly pressed down so as to operate by the actuator portion 33 via the press-connecting blade selection member 34, while an operation pin 36 provided on the top end of the press-connecting blade 28 that does not need to operate is caused to loosely fit in the losing notch 35 formed in the press-connecting blade selection member 34, the downward force that would be otherwise applied to the relevant press-connecting blade 28 by the actuator portion 33 being thereby lost, and the press-connecting blade 28 is thus prevented from being lowered. A sensor C is provided in each receiving case 29 so as to detect whether or not the wire 2 is received therein, as well as the end of the wire 2 so received.

When the wire 2 is inserted between the bottom end of the press-connecting blade 28 and the opening 31 to be held in position in the receiving case 29 with the press-connecting blade 28 needing to operate being lowered, the opening 31 is caused resiliently open so as to allow the wire 2 and press-connecting blade 28 to pass therethrough further downwardly and the wire 2 is press-connected to the connector 16 positioned below the opening 31. Following this the press-connecting blade 28 that has been lowered to complete the press-connecting operation is then restored to its original position by the resilient action of a spring.

The wire drawing mechanism 12 comprises, as shown in FIGS. 4(A), (C), the single laterally elongate main roller 18 and the sub-rollers 19 for individually clamping and/or unclamping the wires 2 on the main roller 18 in cooperation of the main roller 18. These sub-rollers 19 are adapted to individually clamp the wires 2 needing to be fed out so as to feed out the same toward the side of the press-connecting mechanism 13.

Furthermore, in the head portion 14, wire pressing mechanisms 36A and 36B are provided, respectively between the wire drawing mechanism 12 and press-connecting mechanism 13, and behind the press-connecting mechanism 13. The wire pressing mechanism 36A comprises, as shown in FIG. 4(D), a wire holding member 37 and pressing members 38 provided above the wire holding member 37 for individually clamping the wires 2, and this mechanism functions to individually clamp the wires 2 fed out of the wire feed portion 1 and hold them while the head portion 14 travels over the cassette lay-out boards 10A, 10B. The other wire pressing mechanism 36B is, as shown in FIG. 4(E), intended for function as an auxiliary pressing mechanism for individually clamping the wires 2 at the upper edge of the connector fixing jigs 24 via pressing pieces 39 with a view to allowing the head portion 14 to perform a wire press-connecting operation at N end in a smooth fashion.

In this embodiment as shown in FIG. 1(A), a known peeling machine 40 for press-mounting operations and a terminal press-mounting machine 41 are provided in a corner of the table 6 and terminals may be press-mounted on wires, if such is required.

The wire press-connecting and laying out apparatus the main portion of which comprises the above-described wire feed portion 1 and wire press-connecting and laying out portion 3 incorporates automatic control circuits each programmed to carry out a series of operations required to form a specific wire harness. In other words, an automatic control circuit storing a particular program designed to form a wire harness of a particular construction controls a series of required operations, wires 2 needed are selectively fed out to the head portion 14 while the dimension thereof being adjusted, the head portion 14 then selects connectors to which the wires are press-connected and distributes them to the connectors so selected, and the wires are press-connected to the connectors. In addition, the automatic control circuits also control operations of the individual constituent elements, cooperations therebetween, operations selectively performed by particular constituent elements and so forth during a series of required operations.

A wire harness is automatically formed by the action of the automatic control circuits as will be described below. When the leading ends of wires 2 are caused to protrude from the distal end of the wire feed portion 1 for the distribution to connectors, the wire drawing mechanisms 12 of the head portion 14 selectively draws wires 2 needed, and the wires 2 so selected are, as shown in FIG. 4(A), clamped by means of the wire clamping mechanism 36A, and the leading ends of the wires are thus transferred to the head portion 14. When the head portion 14 starts to move, the wires 2 are fed out by means of the wire dimension adjusting and feeding out mechanism 7. When the head portion 14 arrives at a position above a predetermined connector 16' on the cassette lay-out board 10A on which a wire press-

connecting operation is to be first carried out the wire drawing mechanism **12** is, as shown in FIG. **6**(A), caused to operate so as to insert the leading end of the selected wire **2** into the wire press-connecting portion **30**, subsequent to which the press-connecting blade **28** is selectively lowered so that only the wire needing to be press-connected are press-connected to the connector **16'** at M end thereof. Following this, the head portion **14** then moves to another connector **16**, to which the remaining clamped wire is press-connected at M end thereof in the same manner.

When the wires clamped by the head portion **14** have been press-connected to the predetermined connectors at M ends thereof, the head portion **14** lays out the clamped wires in required configurations while feeding them out rearwardly with the intermediate portions thereof being allowed to suspend into the depression **15** so as to be received therein, and the head portion **14** then moves toward the cassette layout board **10B**. The wires clamped by the head portion **14** are fed out by means of the wire dimension adjusting and feeding out mechanism **7** while the dimension thereof being adjusted by the same mechanism **7**, and when the wires are fed out to a predetermined dimension, they are individually severed by the severing mechanism **9**.

As shown in FIG. **6**(B), the head portion **14** moves and stops over a predetermined connector **16"** on which a wire press-connecting operation is to be first carried out with N ends of the wires being held thereon by means of the wire pressing mechanism **36A**, and the wire pressing mechanism **37B** is actuated so as to selectively fix only the wire to be press-connected to the connector **16"** to the upper end of the connector fixing jig **24** for the stabilization of the posture thereof, subsequent to which as soon as the wire pressing mechanism **36A** is released, the wire press-connecting portion **30** is caused to selectively press-connect only the wire needed to the connector **16"** at N end thereof. The head portion **14** then moves to another connector to which the remaining clamped wire is to be press-connected at N end thereof, and the relevant wire is then press-connected to the connector accordingly.

The above-described operations are repeated in a sequential manner, thereby making it possible to automatically form a wire harness forming unit A having press-connected connectors that satisfies a wire laying out requirement for a wire harness being made with the connectors **10** being secured to the cassette lay-out boards **10A**, **10B**.

The wire harness forming unit A completed as described above is then placed on a forming conveyor **20**, and the cassette lay-out boards **10A**, **10B** are spaced at the normal span thereof, the wire harness forming unit A being thereby laid out properly on the conveyor as shown in FIG. **1**(C). The bundle of wires are then set on lay-out branching jigs **21** provided on the conveyor **20** so that a required lay-out configuration for a wire harness being made is completed, and bundling taping, grommets and other accessory parts are mounted on the wires. Finally the connectors **16** are dismounted from the cassette lay-out boards **10A**, **10B** thus making it possible to form a desired wire harness.

In the above press-connecting operations, in a case where a lay-out configuration requires a connector **16** to be press-connected to an intermediate position along the length of the wire **2** the head portion **14** moves to a predetermined intermediate connector **16** after the press-connecting of wires has been completed at M ends thereof as shown in FIG. **6**(C), the relevant intermediate portion of the wire is press-connected to the intermediate connector **16** by the wire press-connecting portion **30**. In addition, in a case where the wire has to be press-connected to a connector **16** diagonally disposed relative to the X and Y axes, the head portion **14** is then caused to rotate so as to adjust the direction of the wire, and the wire is properly press-connected to the predetermined connector **16**. Furthermore, in a case where a solderless terminal has to be mounted on the wire, the head portion **14** moves to the peeling machine **40** and terminal-mounting machine **41**, and the terminal is then press-mounted to the end of the wire held by the wire pressing mechanism **36A** and protruding from the head portion **14**. The solderless terminal so press-mounted on the wire is inserted into a predetermined connector during the wire harness forming operation that is carried out on the forming conveyor **20**.

In the first embodiment as described above, the wires are transferred from the wire feed portion **1** to the head portion **14** having the wire press-connecting mechanism comprising a plurality of wire press-connecting portions, and the head portion **14** holding the wires sequentially moves to the connectors provided on the cassette lay-out boards **10A**, **10B** that are disposed within a short distance in such a manner as to be opposite to each other via the depression **15**, and the wires are laid out in a predetermined configuration with the intermediate portions of the wires being allowed to suspend into the depression **15** so as to be received therein. Afterwards the wires so distributed are press-connected to the connectors in a sequential fashion, thereby making it possible to automatically form a wire harness forming unit A in which the wires having the press-connected connectors are laid out in a required configuration for a wire harness being made. With this construction of the present invention the whole travelling distance and the number of travelling strokes of the head portion **14** can remarkably be reduced respectively. Moreover it is possible to efficiently select circulation paths between the groups of connectors, and due to this the efficiency of the press-connecting and laying out of wires can remarkably be improved. Furthermore the cassette lay-out boards **10A**, **10B** are disposed with in a short distance in such a manner as to be opposite to each other via the depression **15**, and this construction requires less space to form a wire harness compared with the prior art lay-out boards which are formed into an actual dimensions of a wire harness to be made, thereby making it possible to make the size of the apparatus smaller.

Modifications that can be made to the first embodiment of the present invention will now be described. Although not shown in the drawings the dimension adjusting mechanism of the wire dimension adjusting and feeding out mechanism **7** of the wire feed portion **1** is transferred to the wire drawing mechanism **12** of the head portion **14** so that the dimension of the wires may be adjusted while they are being drawn during the transfer of the head portion **14**, and the severing mechanism **9** of the wire feed portion **1** may be mechanically interlocked with the adjustment of the dimension of the wires performed in the head portion **14**. In addition, the direction in which the connectors are disposed on the cassette lay-out boards **10A**, **10B** may be restricted in such a manner that the direction in which the wires are press-connected to the connectors **16** becomes parallel to the Y axis along which the head portion **14** is trans-

ferred, and the rotation mechanism of the head portion 14 may be omitted. Furthermore, a transfer mechanism for enabling transfer in the X axis dimension may be provided on the table 6, and alternately the X axis dimension transfer mechanism of the head portion 14 may be omitted. Thus the relative position between the head portion 14 and the two dimensions of the cassette lay-out boards 10A, 10B may be freely taken by allowing the table 6 to travel along the X axis, while the head portion 14 is allowed to travel along the Y axis. Moreover, the wire clamping function of the wire drawing mechanism 12 may be utilized instead of the wire pressing mechanism 36A, and thus the latter may be omitted.

Furthermore, as shown in FIG. 7, a cassette lay-out board 10C on which intermediate connectors 16 to which the intermediate portions of the wires are press-connected are arranged may be provided between the cassette lay-out boards 10A, 10B, and depressions 15 may be provided, respectively, between the cassette lay-out boards 10A and 10C and between the cassette lay-out boards 10C and 10B. Thus, the construction in which the three cassette lay-out boards are used may be adopted. Alternatively, as shown in the same drawing, non-symmetrical cassette lay-out boards 10A, 10B may be utilized.

Referring to FIG. 8, the second embodiment of the present invention will now be described. In this second embodiment, the wire press-connecting mechanism 13 of the head portion 14 utilized in the first embodiment is omitted. Instead, independent press-connecting presses 43 are provided at positions adjacent to the outer edges of the cassette lay-out boards 10A, 10B, and a transfer mechanism for enabling transfer along the X axis is provided on the table 6. The head portion 14 is provided at the laterally central position of the travelling portal frame 11 adapted to travel along the sides of the frame 5 in such a manner as to vertically suspend therefrom, and the direction in which it is disposed is fixed.

A slide mechanism for enabling transfer along the Y axis is provided on the press-connecting press 43 so as to allow the press to move towards and/or away from the cassette lay-out boards 10A, 10B, and a wire holder 42 is provided on the connector fixing jig 24. This wire holder 42 may be formed for instance as shown in FIG. 8(B), such that the wire is temporarily held in the slot portion formed therein. The wire feed portion 1 cassette lay-out boards 10A, 10B and the depression 15 are the same as those utilized in the first embodiment and the head portion 14 is also provided with the same wire drawing mechanism 12 and wire pressing mechanism 36A as those utilized in the first embodiment.

When the head portion 14 and the table 6 are moved relative to each other the wires 2 fed from the wire feed portion 1 are sequentially distributed to the wire holders 42 on the connectors 16 arranged on the cassette lay-out boards 10A, 10B so as to be temporarily held in position, and the wires are thus laid out. The connectors 16 to which the wires are so held are then sequentially brought in front of the press-connecting press 43 by moving the table 6 along the X axis, and the wires 2 temporarily held on the wire holders 42 are then sequentially press-connected to the connectors 16 by the press-connecting press 43 when it is moved forward.

The wire press-connecting and laying out apparatus according to this embodiment, which is shown in FIG. 8, has also the connectors 16 on the cassette lay-out boards 10A, 10B that are disposed within a short distance in such a manner as to be opposite to each other via the depression 15, the cassette lay-out boards and the wire dispensing head portion 14 that can freely take any relative position along the two dimensions. Thus, with the second embodiment, a function similar to that of the first embodiment shown in FIG. 1 can also be expected.

As is clear from the above description, with the automatic wire press-connecting and laying out apparatus according to the present invention, the efficiency of the press-connecting and laying out wires can remarkably be improved, and moreover, it is possible to obviate the necessity of enormous space for the laying out of wires. Consequently, the present invention is advantageous in that the productivity of wire harnesses can remarkably be improved.

What is claimed is:

1. An automatic press-connecting and laying out apparatus for a wire harness having a press-connecting and laying out portion, comprising:

a wire feed portion having a wire feeding mechanism adapted to individually feed out a plurality of wires and a severing mechanism for individually severing each of said plurality of wires at a predetermined length;

cassette lay-out boards detachably and horizontally spaced apart with a depression therebetween, each of said boards having a group of connectors detachably arranged at predetermined positions thereon; and

a head vertically suspended over said boards and adapted to move along orthogonal X and Y axes of said cassette lay-outs boards and to rotate about a vertical axis perpendicular to said X and Y axes, said head comprising a wire drawing mechanism for individually drawing each of said plurality of wires and a wire press-connecting mechanism comprising a plurality of wire press-connecting portions adapted to individually press connect each of said plurality of wires to said connectors, said wire drawing and wire press-connecting mechanisms facing downwardly;

a wire length metering mechanism for individually measuring said length of each of said plurality individual wires on said wire feeding mechanism or on said wire drawing mechanism;

said head adapted to individually clamp each of said plurality of wires protruding from the distal end of said wire feed portion and sequentially distribute and press connect each of said plurality of wires to said connectors, whereby said wires are laid out in a required configuration with intermediate portions thereof being allowed to depend into said depression.

2. The apparatus of claim 1 wherein said plurality of wire press-connecting portions has a press-connecting blade selection mechanism whereby said press-connecting portions can be selectively actuated.

3. An automatic press-connecting and laying out apparatus for a wire harness having a press-connecting and laying out portion, comprising:

a wire feed portion having a wire feeding mechanism adapted to individually feed out a plurality of wires and a severing mechanism for individually severing each of said plurality of wires at a predetermined length;

cassette lay-out boards detachably and horizontally spaced apart with a depression therebetween, each of said boards having a group of connectors ar-

ranged at predetermined positions thereon, and having a travel mechanism for movement;

a head vertically suspended over said boards, said head and said boards movable relative to each other along X and Y axes and rotatable relative to each other about a vertical axis which is perpendicular to said boards, and a wire drawing mechanism for individually drawing wires at the lower portion thereof; and

presses adapted to press connect each of sid plurality of wires individually at positions adjacent the outer edges of said boards;

said connectors detachably mounted on connector fixing jigs each having a wire holder for temporarily holding a wire, said head portion clamping said wires protruding from the distal end of said wire feed portion and sequentially distributing said wires to said wire holders, said wires being laid out in a predetermined configuration with intermediate portions thereof received in said depression, and said wires being press-connected to said connectors by means of said presses.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 5,052,449

DATED : October 1, 1991

INVENTOR(S) : Fukuda, et al

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the drawings sheet 4 of 11 should be deleted to replaced with sheet 4 of 11 as per attached.

Signed and Sealed this

Twenty-second Day of June, 1993

Attest:

Attesting Officer

Michael K. Kirk

MICHAEL K. KIRK

Acting Commissioner of Patents and Trademarks

Fig. 2(A)

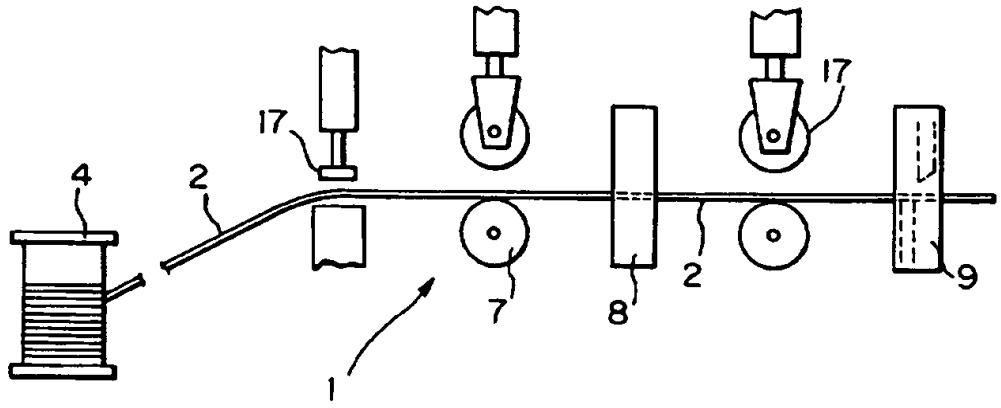
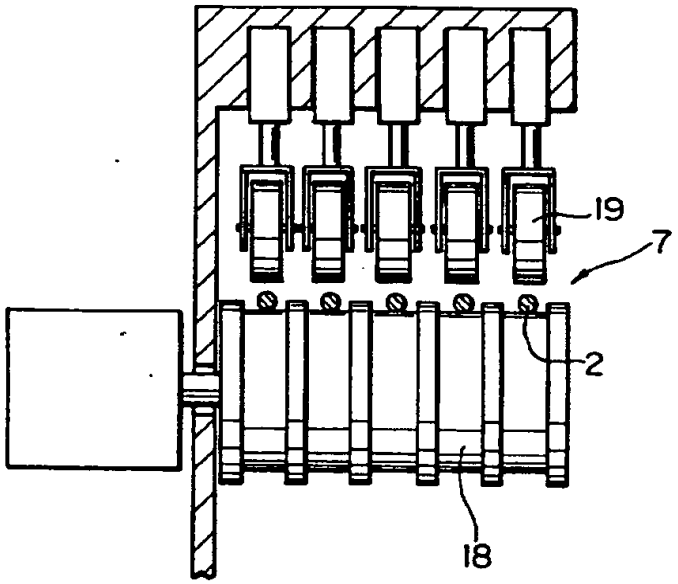


Fig. 2(B)



US005485660A

United States Patent [19]

Pittau

[11] Patent Number: 5,485,660

[45] Date of Patent: Jan. 23, 1996

[54] **MACHINE FOR CONNECTION CONNEXION ELEMENTS INTO CONNECTORS**

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[73] Assignee: **Aerospatiale Societe Nationale Industrielle**, Paris, France

[21] Appl. No.: **231,114**

[22] Filed: **Apr. 22, 1994**

Related U.S. Application Data

[62] Division of Ser. No. 945,623, Sep. 16, 1992, Pat. No. 5,333,374.

[30] **Foreign Application Priority Data**

Sep. 26, 1991 [FR] France 91 11867

[51] **Int. Cl.**[6] **B23P 21/00**; H01R 43/20

[52] **U.S. Cl.** **29/718**; 29/721; 29/748; 29/789

[58] **Field of Search** ..... 29/33 M, 747–749, 29/754, 755, 759, 789, 790, 794, 797, 881, 884, 717, 718, 721, 786; 439/350, 352

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Primary Examiner—Peter Vo

Attorney, Agent, or Firm—Fisher, Christen & Sabol

[57] **ABSTRACT**

The invention relates to an automatic connection machine having at least two connecting devices for connecting connexion elements equipping the ends of electrical conductors into connector housings. The device (5) comprises:

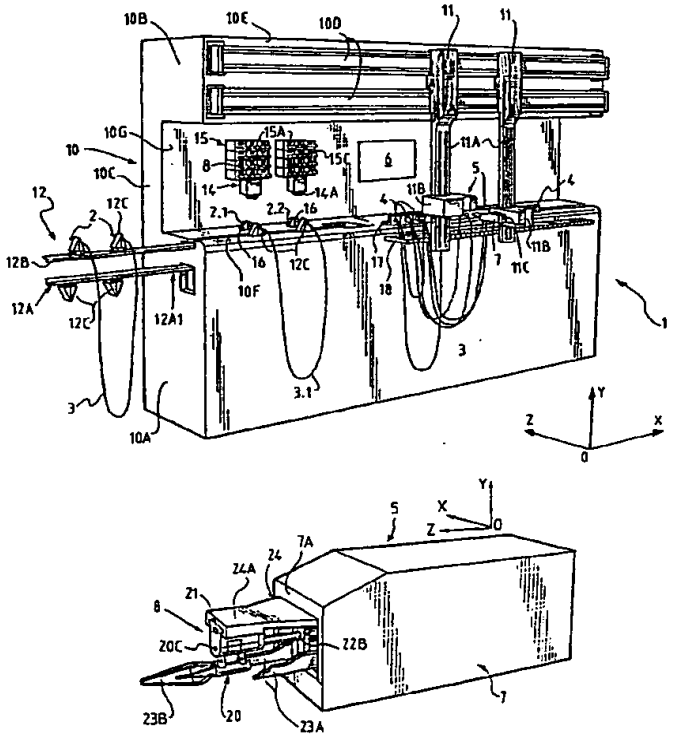
a body (7) which can be displaced in the direction of the connector (4);

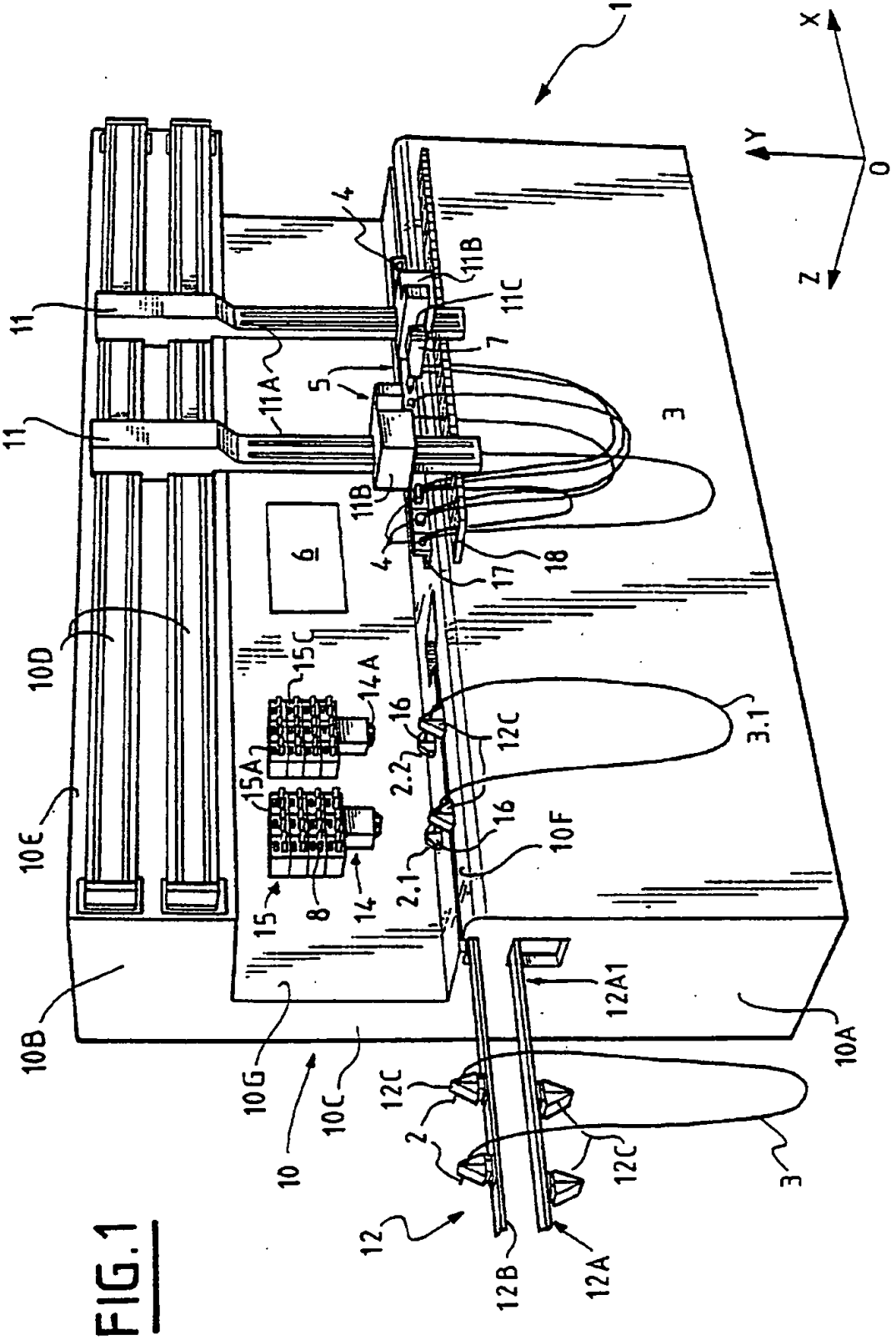
an insertion member (8) provided with means for grasping the connexion element (2) to be inserted into the corresponding housing of the connector (4);

removable means for fixing the insertion meet (8) to said body (7); and,

means for controlling said grasping means, associated with the body (7) and capable of assuming, when the insertion member (8) is locked, a first position, in which the grasping means hold the connexion element (2) and enable it to be inserted into the corresponding housing of the connector, and a second position, in which the grasping means release the connexion element which is then connected in the connector housing.

6 Claims, 8 Drawing Sheets

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11C
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15C
14A
16
12C
3.1
15A
2.2
10E
16
10F
2.1
15
8
14
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12C
2
10
12C
3
12
12B
12A

FIG.1

FIG. 2

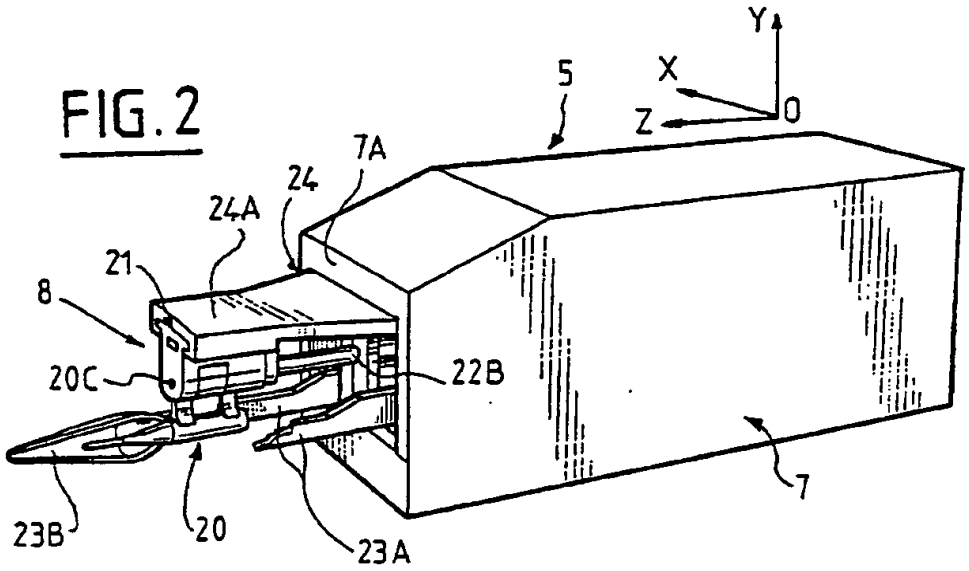


FIG. 3

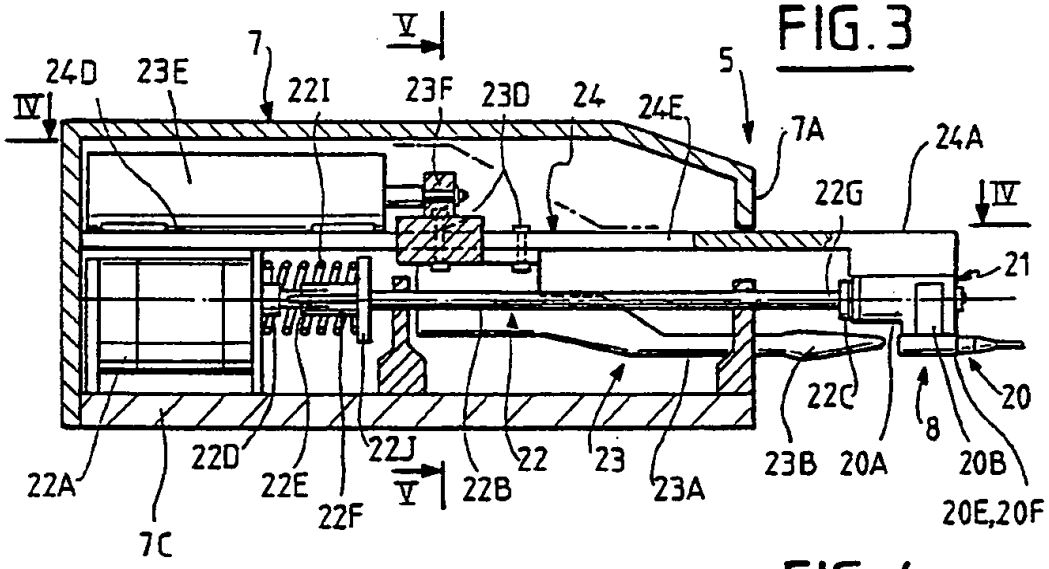
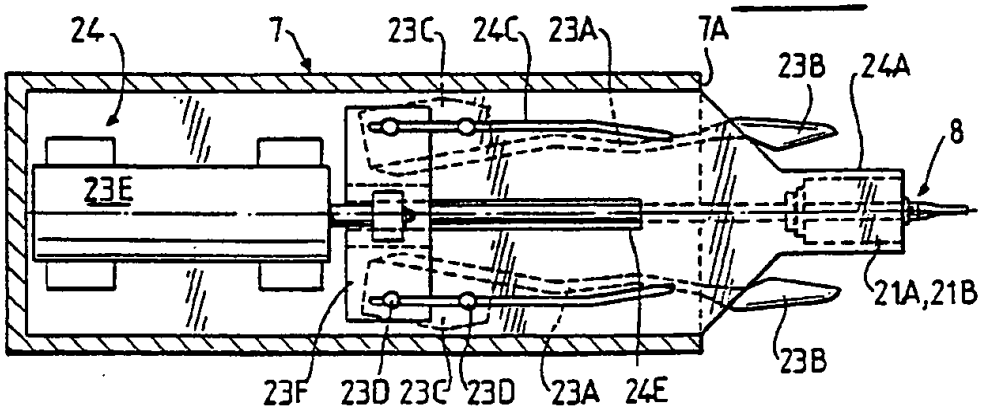
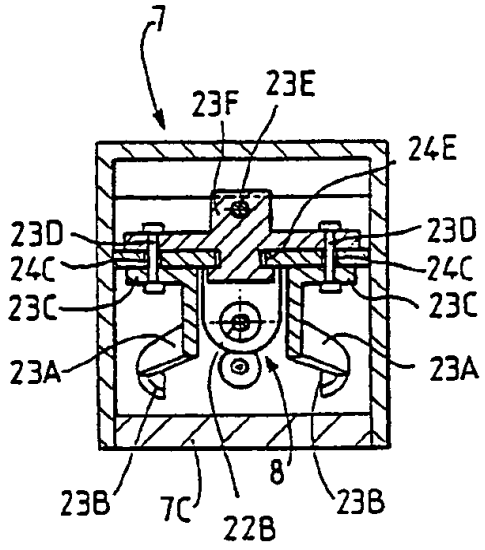


FIG. 4

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23F
23E
24E
23D
24C
23C
23A
23D
24C
23C
23A
23B
7C
22B
8
23B

FIG. 5

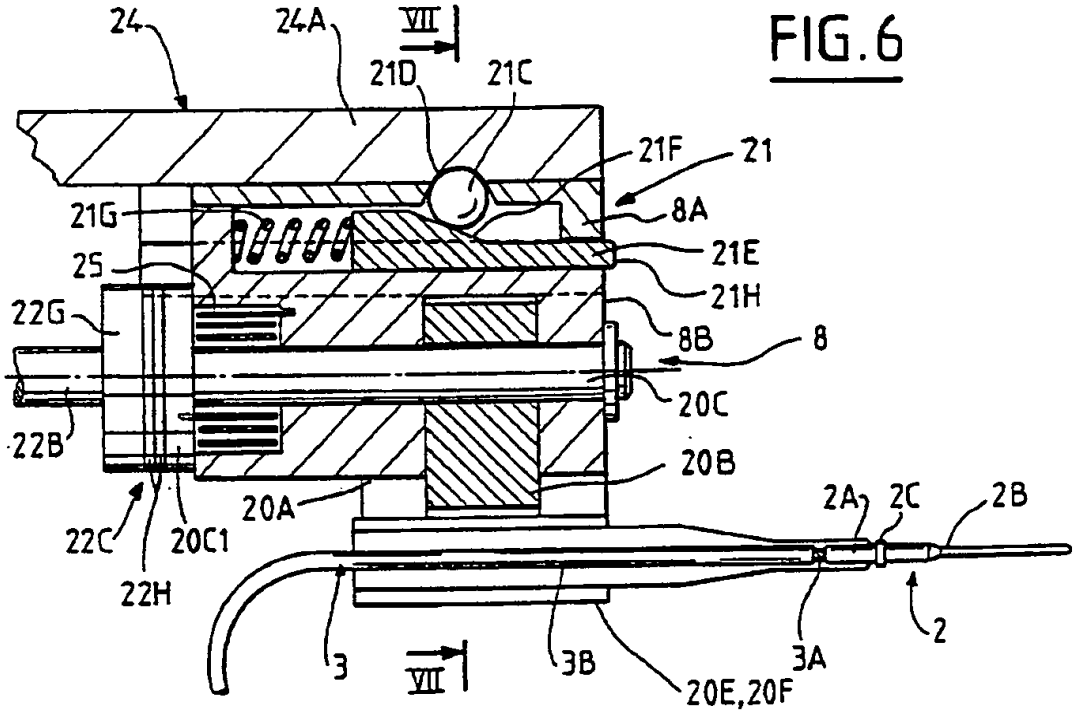

24
24A
VII
21D
21C
21F
21
21G
8A
21E
25
21H
22G
8B
8
20C
22B
20B
20A
2A
2C
2B
22C
20C1
22H
2
3
VII
3B
3A
20E,20F

FIG. 6

FIG.7

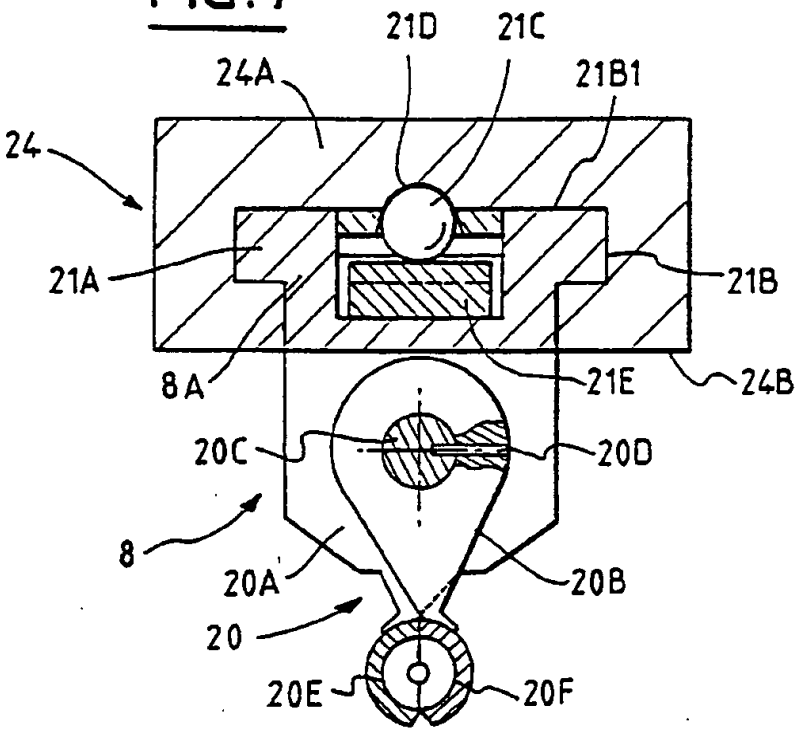
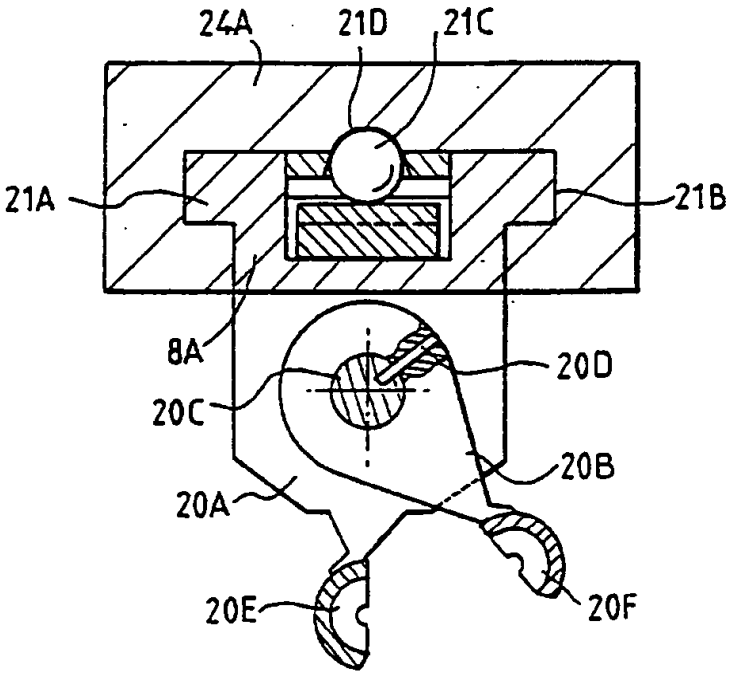
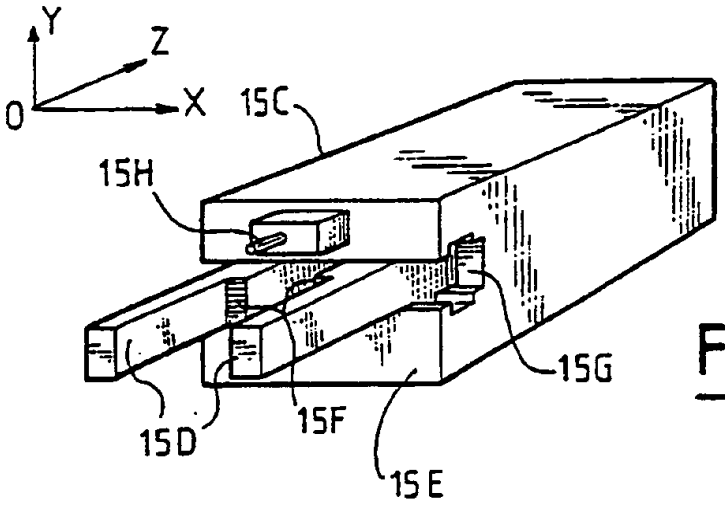


FIG.8




Y
Z
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X
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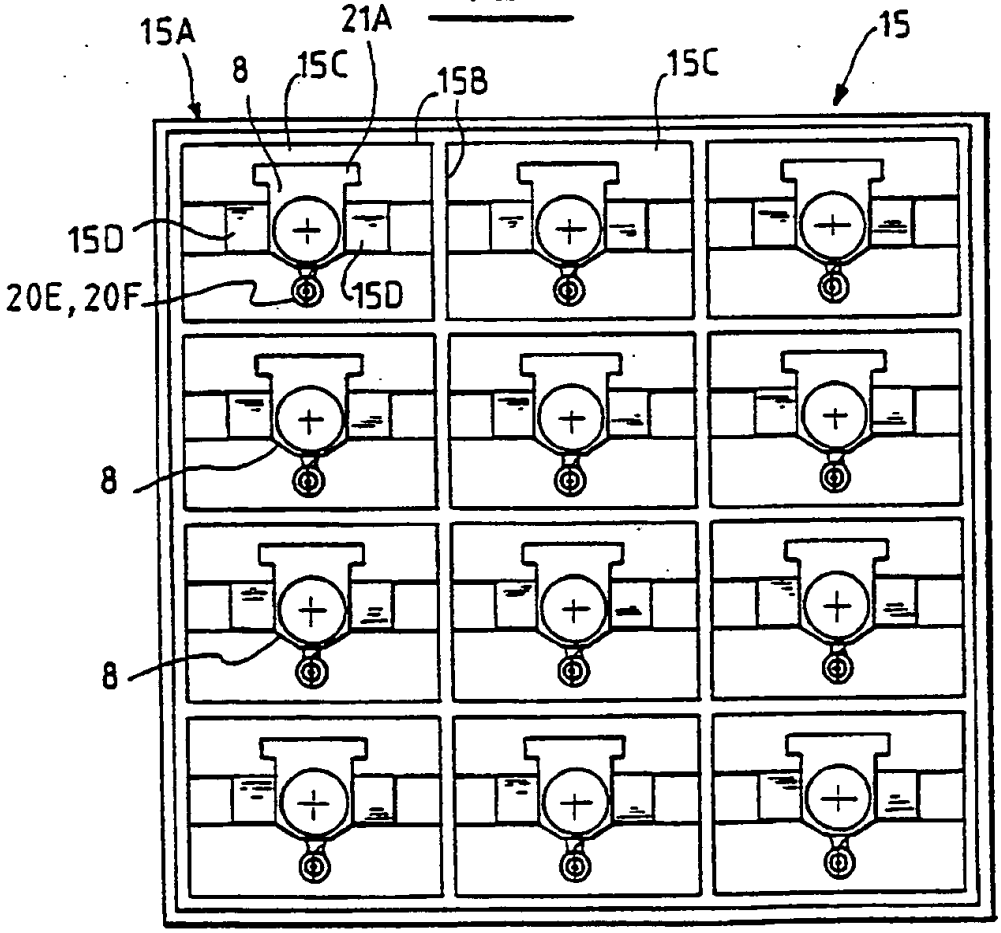
15G
15D
15F
15E

FIG.10

FIG.9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8
15C
21A
15B
15C
15
15D
20E, 20F
15D
8
8

FIG.11A

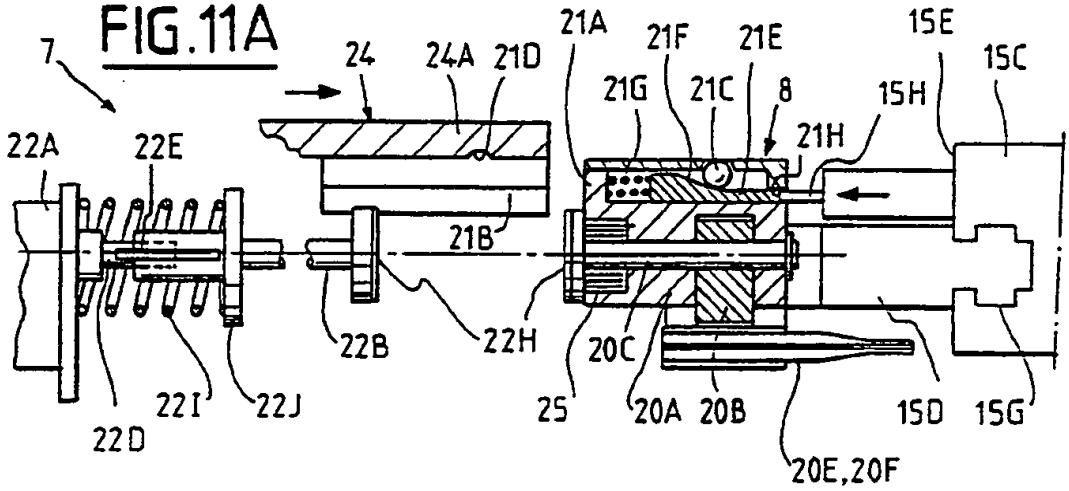


FIG.11B

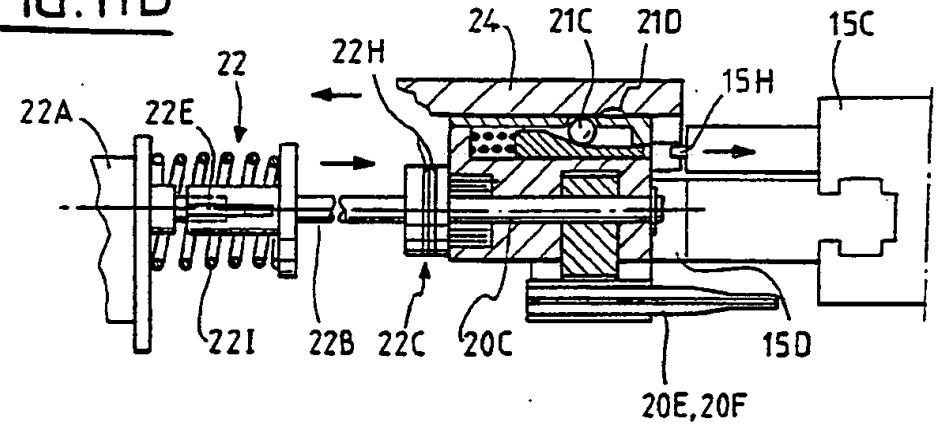


FIG.11C

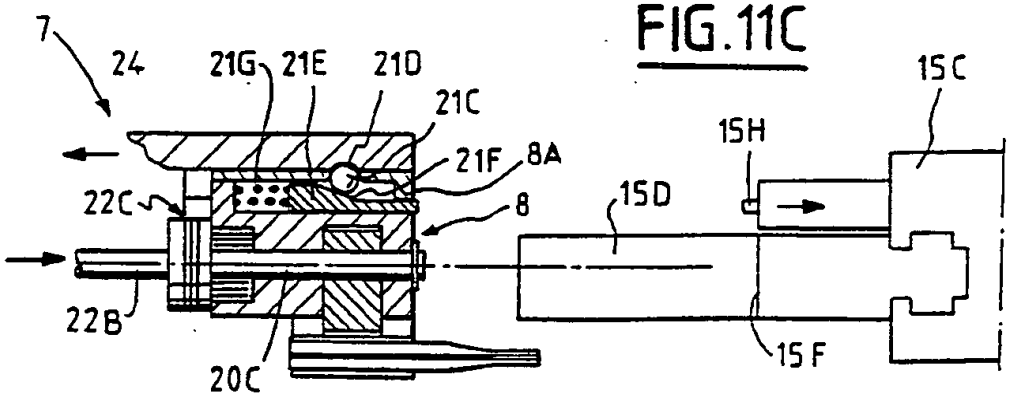


FIG. 12

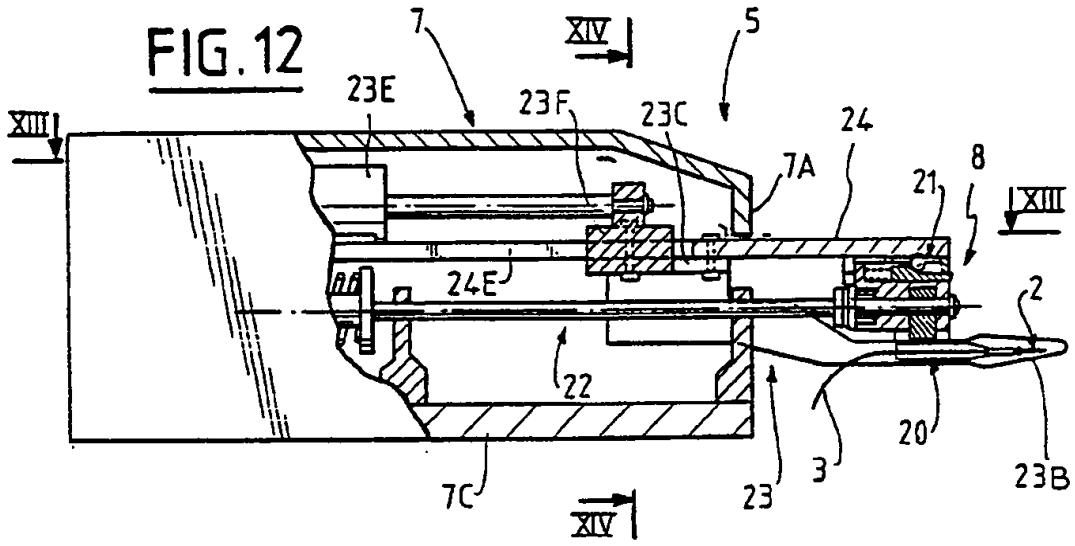
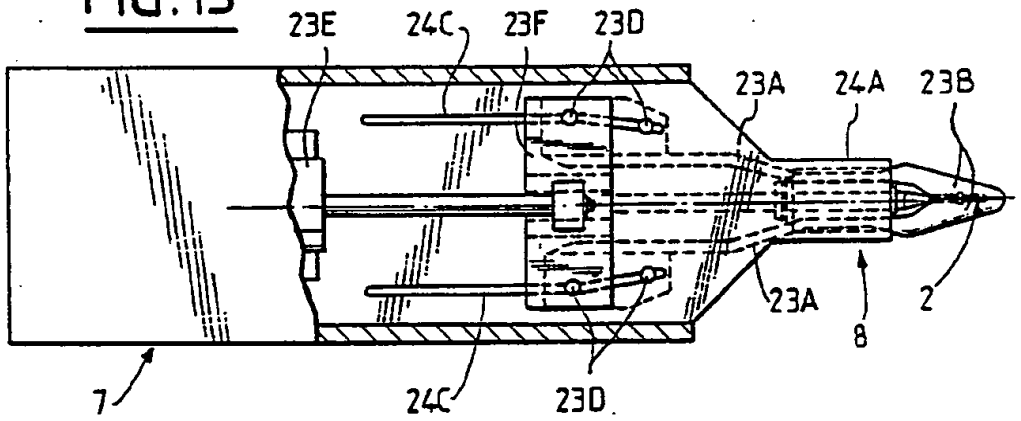


FIG. 13



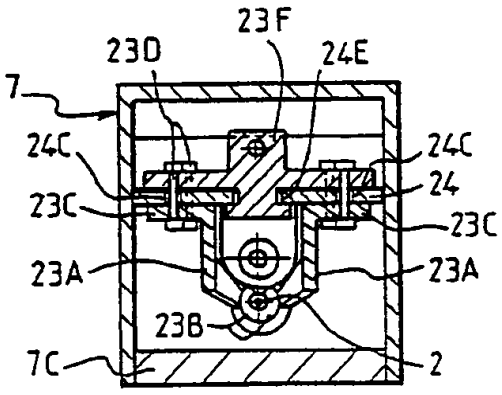


FIG. 14

FIG.15A

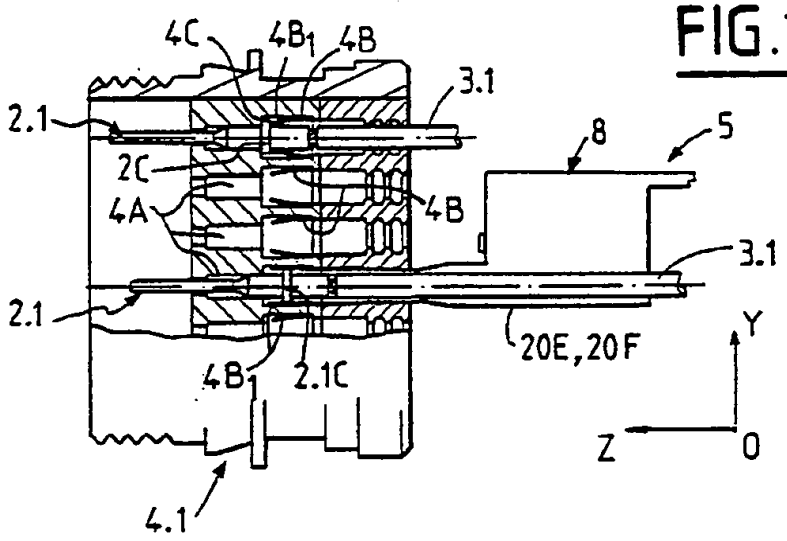
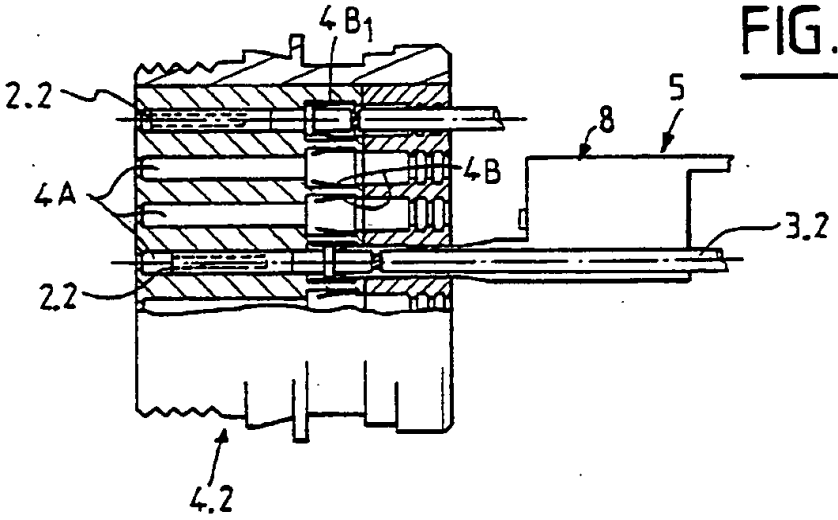


FIG.15B



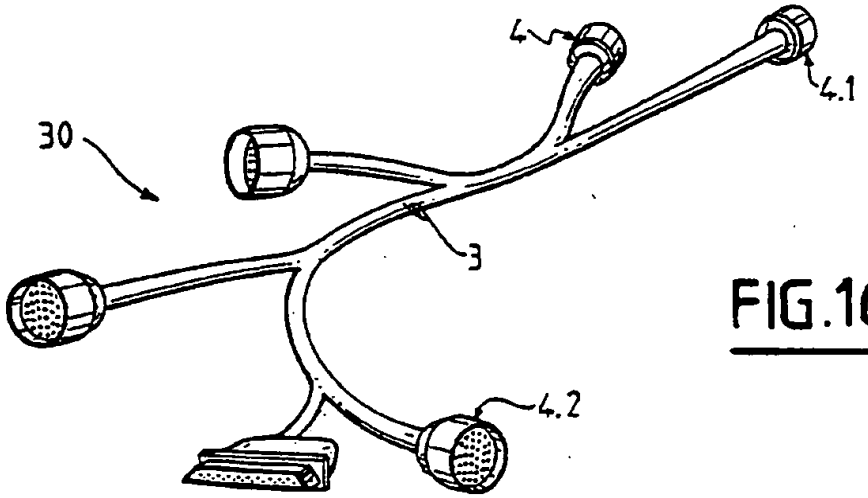


FIG.16

MACHINE FOR CONNECTION CONNEXION ELEMENTS INTO CONNECTORS

This application is a division of U.S. application Ser. No. 07/945,623, filed on Sep. 16, 1992 now U.S. Pat. No. 5,333,374.

Priority of foreign application number 91 11867, filed on Sep. 26, 1991 in France is claimed under 35 U.S.C. 119. The certified copy has been filed in prior application number Ser. No. 07/945,623, filed on Sep. 16, 1992.

The present invention relates to a device for connecting connexion elements equipping the ends of electrical conductors, into connector housings, as well as to an automatic connexion machine comprising such devices.

The device according to the invention is more particularly intended for the plugging of male and/or female pins, which have previously been mounted, usually by crimping, onto the ends of the conductors of electrical cables, into the corresponding reception housings of connectors, which may have a circular, rectangular or other shape and in which the operation of plugging or of connexion of the pins usually takes place via their rear face.

Furthermore, such a connexion device and the machine which is equipped therewith have a preferred application in the aeronautical field. Indeed, the vast number of electrical cables, intended to join up the various apparatuses and items of equipment of the aircraft, via specific connectors, in order to ensure that it functions correctly, involves many preliminary operations for connecting the pins, at the ends of the conductors of said cables, into corresponding housings of the specific connectors so as subsequently to make up cabling bundles or harnesses.

The connectors of each bundle, equipped with pins, are then engaged into complementary connectors provided on the items of equipment.

It goes without saying that the device and the connexion machine according to the invention could apply to other industrial fields, for example the automotive industry, wherever these involve many connexions between connexion elements and connectors.

At present, the operations of connexion of such connexion elements, such as male and female pins, into connector housings are carried out manually by means of ordinary insertion tools. For example, an operator installs one of the two pins, which have been previously crimped to the ends of the conductor of said electrical cable, into the axial passage of said insertion tool until the rib, which is provided on each pin, presses against the end face of the tool. The pin, held inside the tool, is then inserted into the corresponding housing of the connector in question, in such a way that the rib of the pin comes to bear against an internal shoulder in the housing while being, moreover, axially locked by the elastic tabs of a socket usually provided inside the housing.

The operator then removes the tool, now without the pin, and can proceed to install the other pin of the cable into the corresponding housing of another connector, with the same or a different tool.

It is therefore clear that a lengthy and tedious task must be undertaken in order to connect all the connexion elements into the corresponding housings of the specific connectors, in order to produce each cabling bundle. These connexion operations therefore require a large technical staff and considerable working time.

Furthermore, depending particularly on the intensity of the electrical currents and on the shape of the connectors and their housings, a plurality of connexion elements such as male or female pins, having different geometrical characteristics (shape, length, diameter, . . . ,) are used, which involves the use of many specific insertion tools, each

corresponding to a particular type of connexion element. Consequently, the risk of errors occurring, due to a wrong choice of pin, of insertion tool, of connector housing, or even of connector, is not negligible. Therefore, in order to prevent these possible errors which could have serious consequences, further checking operations are to be carried out in order to ensure that each pin equips the corresponding housing of the connector in question, and that the pins are properly connected and held inside the housings of said connectors.

The aim of the present invention is to remedy these disadvantages and it relates to a connexion device, the design of which makes it possible to facilitate the various operations of inserting the connexion elements into the connector housings and, consequently, to reduce the time needed to mount these elements.

For this purpose, the device for connecting connexion elements, such as pins, equipping the ends of electrical conductors, into connector housings, is noteworthy, according to the invention, in that it comprises:

- a body which can be displaced in the direction of said connector;
- at least one insertion member provided with means for grasping said connexion element to be inserted into the corresponding housing of the connector;
- removable means for fixing said insertion member to said body, allowing the locking or unlocking of said member relative to said body; and,
- means for controlling said grasping means, associated with said body and capable of assuming, when said insertion member is locked, a first position, in which said grasping means hold said connexion element and enable it to be inserted into the corresponding housing of the connector, following the displacement of the body along a direction parallel to said housing, and a second position, in which the grasping means release said connexion element which is then connected in the connector housing.

Thus, after having locked the selected insertion member on the body, as a function of the dimensional characteristics of the connexion element, the mounting operations for grasping and inserting the connexion element into the corresponding connector housing are carried out automatically, which makes it possible to reduce the number of manual operations and to ensure correct connexion of the connexion element into the connector.

Advantageously, said insertion member, once it is locked on the body, projects from said body in order to face the connector to be equipped. Thus, this arrangement greatly facilitates the mounting and dismantling of said members on the body of the device. There is no risk of the body, which is then at a distance from the insertion member carrying the connexion element, damaging the cables already connected to the connectors, during its displacement in the direction of connector in question, parallel to the housing.

Preferably, said body has a hollow and approximately parallelepipedal shape, inside which said means for controlling the means for grasping said insertion member are arranged. The body therefore defines a hollow box, without any external bumps, thereby preventing the already connected cables from becoming entangled thereon. In addition, the control means are then protected inside the body.

In a preferred embodiment, said removable fixing means comprise a tenon and mortise assembly allowing said insertion member to slide on the body, and a ball lock enabling the insertion member to be immobilized in position relative to said body. It will therefore be noted that the production of

said fixing members is straightforward, which ensures that they operate reliably during use. More particularly, the tenon/mortise assembly of said insertion member on the body is arranged parallel to the direction of displacement of the body toward the connector, and of mounting of the connexion element into the corresponding housing of said connector.

Structurally, the tenon of said assembly can be provided on a base of said member and has a T-shaped cross section, while the mortise, having a cross section complementary to that of the tenon, is provided on the end of a plate standing out from said body, and the locking ball is housed partially inside the base of said member in order to engage, by virtue of the action of a cam-forming part stressed by a spring and controllable from the outside, in a corresponding recess provided in said plate.

Furthermore, said means for grasping the connexion elements are, for example, of the clamp type and so comprise two jaws which can be displaced in relation to one another, under the action of said control means, between a closed position, in which said connexion element is grasped, held, then introduced into the corresponding housing of the connector, and an open position, in which said element, thus inserted into its housing, is released by said jaws. More particularly, these jaws are mounted about an articulation spindle, parallel to the direction of displacement of the body and of mounting of said connexion elements, and joined up to said control means, and one of said jaws is stationary and solidly fixed to the base of said insertion member, whereas the other jaw is movable and joined up to said articulation spindle. Once again, the straightforward production of said grasping means is noted, which further guarantees a reliable operation.

In addition, said means for controlling said grasping means comprise a motor which is capable of driving said grasping means using a friction mechanism.

In this case, said motor, which is housed inside said body, is placed coaxially to the articulation spindle of said jaws and it interacts with said spindle by means of an intermediate shaft pressed axially against said articulation spindle, and said friction mechanism consists of disks which are respectively provided and associated with the intermediate shaft and with said spindle.

Advantageously, a torsional spring respectively joins up, by means of its ends, the two jaws forming the means for grasping said member, so that said jaws are spontaneously pulled back and held in the closed position when said insertion member is withdrawn from said body.

According to another characteristic of the invention, the device comprises, in addition, means for protecting said connexion element held in said insertion member, said protection means being associated with said body and capable of covering said connexion element until the time when it is to be inserted into the corresponding housing of the connector. In a preferred embodiment, these protection means may comprise two movable shields placed respectively on either side of said insertion member, and capable of assuming, by virtue of actuating means, a remote open position away from said insertion member and a closed position surrounding said connexion element carried by the grasping means. Consequently, these shields prevent the connexion elements, which often have dimensions of the order of millimeters, from being damaged during their approach toward the connector housings. The shields thus force their way through between the already connected cables, after which they are retracted when the connexion element is then facing the corresponding connector housing.

More particularly, the two shields are respectively mounted, via spindles, in symmetrical and converging guiding slots provided in the plate of said body, carrying said insertion member, and said actuating means consist of a jack housed inside said body and driving, via a carriage sliding on said plate, the spindles of said shields between their open position and their closed position, the spindles sliding in the converging slots in the direction of said member.

The present invention furthermore relates to a machine for automatically connecting connexion elements, such as pins, equipping the ends of electrical conductors of cables, into connector housings.

For this purpose, it comprises:

- at least two connecting devices, such as those defined previously and intended to deal respectively with the two connexion elements provided at the ends of each cable, the body of each device intended to carry an insertion member, being capable of being displaced, relative to the frame of the machine, along the OX, OY and OZ axes of an orthonormal reference system;
- a plurality of connectors, the housings of which are intended to receive the corresponding connexion elements, and which are placed on said frame;
- means for visualizing the positions of the connexion elements equipping the respective ends of each cable;
- an area for storing the various insertion members which are capable of being locked to said respective bodies, and which are selected as a function of the geometrical characteristics of said connexion elements to be connected; and
- a programable directing unit containing the information relating to the various connexions to be carried out depending on the connexion elements provided at the end of each cable, and on the housings of said connectors, as well as the types of insertion members to be selected as a function of the connexion elements to be connected, and to which unit are joined up the means for controlling the means for grasping each selected member, and the means for actuating said protection means and the displacements of each body along the OX, OY and OZ axes of said reference system.

Thus, it is understood that the cycle of connecting the connexion elements into the connector housings is automatically controlled and run by the directing unit, from the time when the connexion elements of each cable are grasped by the two connexion devices, until the time when they are inserted into the corresponding housings.

Furthermore, the machine additionally comprises means for successively conveying said cables to be connected, equipped with said connexion elements, in front of said visualizing means, said conveying means being joined up to said programable directing unit. The connexion operations are thus completely automated from the moment when the cables, equipped at their ends with the connexion elements, are removed from the crimping machine. More particularly, said conveying means comprise an endless conveyor on which the two ends of each cable, equipped with said connexion elements, are placed, via clamps associated with the conveyor.

In a preferred embodiment, the body of each device is mounted on a movable part attached to the frame, each of said movable parts comprising a crosspiece which is capable of sliding, along the OX axis of said reference system, on at least one beam solidly fixed to said frame, a carriage mounted so as to slide along the OY-axis of said reference system on said crosspiece, and a seat carrying said body and

associated with said carriage so as to slide along the OZ axis of said reference system, said connector housings being placed along the OZ axis of said reference system.

In addition, said storage area can consist of two identical boxes in the compartments of which the various insertion members are housed, via supports, each support being provided with controllable arms for holding the corresponding insertion member and with a piston or the like placed so that it projects from the support and against which the cam-forming part of said fixing means, which is attached to the body of each device, is capable of being applied.

A box of insertion members is thus advantageously allocated to each connexion device and each insertion member is capable of being solidly fixed to the body of the Corresponding device by means of the tenon-mortise Joint and of the ball lock of the fixing means.

Furthermore, said visualizing means comprise for example two cameras associated with the frame and under which the two ends of each cable, provided with said connexion elements, come to a standstill.

The figures of the attached drawing will clearly reveal how the invention may be produced. In these figures, identical references designate similar elements.

FIG. 1 shows a perspective view of an automatic connexion machine according to the invention, advantageously comprising two connexion devices in accordance with the invention.

FIG. 2 shows a perspective view of one of the two connexion devices mounted on the machine, the insertion member being locked on the body of said device.

FIG. 3 shows a longitudinal cross section of the device illustrated in FIG. 2, in particular showing the control means for the means for grasping said member and the means for protecting the connexion element grasped by said insertion member, in the inactive remote position.

FIGS. 4 and 5 respectively show cross sections of the device along lines IV—IV and V—V in FIG. 3.

FIG. 6 shows a cross section at a larger scale of said insertion member fixed to the device body and holding, under the action of the grasping means, the end of an electrical cable equipped with the connexion element such as a male pin.

FIG. 7 shows a transverse cross section of said insertion member along line VII—VII in FIG. 6, showing the grasping means in the closed position.

FIG. 8 shows a view similar to the preceding one, but showing said grasping means of said member in the open position under the action of the control means.

FIG. 9 shows one of the two boxes for storing said insertion members provided on the machine.

FIG. 10 shows a perspective view of one of the supports of said insertion members contained inside each box.

FIGS. 11A, 11B and 11C show partial diagrammatical cross sections showing the three main phases respectively, of advance, of grasping and of retreat, respectively, of said selected insertion member, from its storage compartment to the body of said device.

FIG. 12 shows a view similar to FIG. 3, but it illustrates said device with its member holding the male pin of an electrical cable and with its protection means in the active position, surrounding the pin.

FIGS. 13 and 14 respectively show cross sections of the device along lines XIII—XIII and XIV—XIV in FIG. 12.

FIG. 15A shows the male pin equipping one of the ends of a cable and carried by one of the devices being inserted into the corresponding housing of a connector provided on the machine, while FIG. 15B shows, for example, a female pin equipping the other end of the same cable and carried by the other device being inserted into the corresponding housing of another connector.

FIG. 16 shows, by way of example, a cabling bundle or harness thus obtained.

The automatic connexion machine 1, shown in FIG. 1, is intended for mounting connexion elements 2, provided at the ends of the electrical conductors of cables 3, into the corresponding electrical connector housings 4, in particular via connexion devices 5 and a programable directing unit 6 symbolized by a rectangle. The connexion elements 2, such as pins, equipping the electrical cables will be more particularly described and illustrated in relation to FIGS. 6, 15A and 15B, these last two figures furthermore showing two of the electrical connectors to be equipped.

In this embodiment, the machine 1 advantageously comprises two connexion devices 5, which can be displaced along the OX, OY and OZ axes of an orthonormal reference system of the machine, and intended to each deal with one of he two connexion elements or pins 2 provided a the ends of each electrical conductor in order to insert them into the corresponding housings of two selected connectors 4. To that end, each of the devices 5, which are identical both sructurally and functionally, comprises a body 7 can be displaced along the three axes OX, OY and OZ and an insertion member 8 which is capable of being fixed to the body for grasping, and then inserting said connexion element 2 into the selected housing of the connector 4 in question.

Prior to the description of the devices, which will be further dealt with in relation to FIGS. 2 to 8, the machine 1 is described below, which machine comprises a fixed frame 10, to which the orthonormal reference system OX, OY and OZ relates and which consists of a lower part or base 10A, and of an upper part or portal 10B Joined up to one another by a central part 10C which is set back. The machine also comprises movable parts 11 for the displacement of the devices 5 along the OX, OY and OZ axes, means 12 for automatically and successively conveying the cables 3 provided with connexion elements 2, means 14 for visualizing the connexion elements 2 of each cable 3, an area 15 for storing the insertion members 8, and a plurality of connectors 4 to be connected, the housings of which are intended to receive the connexion elements.

More particularly, by referring to FIG. 1, it can be seen that the movable parts 11 for the displacement of the connexion devices 5 are identical and are carried, in this case, by two horizontal beams 10D which are spaced apart and fixed to the front face 10E of the portal 10B of said frame. These parallel beams 10D are identical and placed along the OX axis of the reference system. The movable parts 11 are mounted on these beams via two vertical crosspieces 11A placed along the OY axis of the reference system and capable of sliding along the horizontal beams 10D. The crosspiece 11A of each part supports a carriage 11B capable of sliding on this crosspiece along the OY axis. The two crosspieces are identical, as are the two carriages. A seat 11C which is capable of being displaced along the OZ axis of the reference system is mounted so as to slide on each carriage 11B and carries, via appropriate fixing means not shown in the figure, the body 7 of the corresponding connexion device 5. The displacements of each device 5, carried by its respective seat-carriage-crosspiece part 11, are of course provided by motors, not shown, joined up to the directing unit 6. In addition, the fact that the parts 11 are carried by two beams 10D increases the mechanical stiffness and ensures accurate displacements.

The means 12 for conveying the cables 3 consist for example of an endless belt 12B (or chain) conveyor 12A, on which evenly spaced pairs of clamps 12C are provided and which runs along the OX axis of the machine 1. This endless belt conveyor 12A, the downstream end 12A1 of which is shown in FIG. 1 arriving into the base 10A of the free, has its upstream end, which is not visible, placed at the output of a crimping machine, for example. This machine places and fixes the suitable connexion elements 2, such as particularly male or female pins, at the ends of the electrical conductors of said cables 3, which have previously been cut to length depending on the distance separating the two connectors to be joined up. Each cable 3, equipped with pins crimped to the ends of the electrical conductor, is automatically placed, via its ends on the consecutive clamps 12C of a same pair provided on the endless belt 12B of the conveyor. Two cables thus clamped on the conveyor 12A are illustrated in FIG. 1.

The means 14 for visualizing the positioning of the connexion elements 2 (pins) consist for example of two cameras 14A placed in parallel approximately above the downstream end 12A1 of the conveyor and associated with the central part 10C of the frame. These cameras 14A, having their axes of sight arranged along the OY axis, make it possible to visualize the connexion elements 2 crimped to the two ends of each electrical cable 3. Furthermore, in order to facilitate the grasping of said connexion elements by the insertion member 8, two controllable identical clamps 16 are provided on the upper face. 10F of the base 10A of said frame and are used to grasp the connexion elements 2 of each cable, on the basis of the information supplied by the cameras 14A, and to move in translation along the OZ axis in order to stretch the ends of each cable 3, so as to withdraw said connexion elements 2 in a plane perpendicular to the axes of sight of the cameras 14A so that they may thus be grasped by the insertion member 8. By virtue of the cameras 14A which are joined up to the directing unit 6, the positions of the connexion elements are fully known and the grasping of said connexion elements 2, firstly by the clamps 16 and secondly by the jaws 20A and 20B of the insertion member is perfectly controlled, as will be revealed subsequently.

The connectors 4, two of which are more particularly illustrated in relation to FIGS. 15A and 15B, are previously mounted in a line on a suitable support 17, not described, capable of holding any type of connector and fixed to the upper face 10F of the base of said frame. These connectors 4, as shown in FIG. 1, may have a variety of shapes (circular, rectangular, . . . ,) and dimensions, and similarly may comprise any number of housings. These housings, designated by 4A in FIGS. 15A and 15B, are arranged along the OZ axis of the machine, thus corresponding to the direction of displacement of the body 7 of each connexion device 5, mounted on the corresponding movable part 11.

As regards the area 15 for storing said insertion members 8, it comprises two identical boxes 15A which are fixed to the front face 10G of the central part 10C of said frame and which have a plurality of compartments 15B. The insertion members 8 are housed respectively in the compartments 15B of each box via respective supports 15C, which will be more particularly described in relation to FIGS. 9 and 10. The insertion members 8 have geometrical characteristics which of course match those of the connexion elements to be grasped, and crimped on the cables. The cameras 14A are located under the two boxes 15A respectively, which makes it possible to limit the displacements of each body from the time when the insertion member is mounted on the body of the corresponding device until the time when the connexion element is grasped.

A box 15A containing the various insertion members adapted to grasp the various connexion elements equipping the corresponding ends of the cables is allocated to each body 7 of the connexion device.

The operation of the machine 1 is run by the programable directing unit 6 to which the various motors for the movable parts 11 and for the endless conveyor 12A in particular are joined up, and which contains, in addition, the information relating to the types of connexion to be carried out between the connexion elements of the cables and the corresponding housings of the various connectors, and to the types of insertion members to be selected depending on the connexion to be carried out.

FIG. 2 shows one of the two connexion devices 5 in accordance with the invention. The body 7 of this device, which is fixed to the seat 11C which can be displaced along the direction OZ on the carriage of the corresponding movable part 11, carries one of the insertion members 8 available in the storage area 15 and selected as a function of the connexion to be carried out, that is to say of the geometrical characteristics of the connexion element 2 to be connected. This insertion member 8 is provided with grasping means 20 for grasping the connexion element 2 to be connected, and with removable fixing means 21 which enable it to be locked or unlocked from the body 7. This body has the shape of an approximately parellelepipedal box, inside which are advantageously housed, means 22 for controlling the grasping means 20 and means 23 for protecting the insertion member 8 intended to hold the connexion element 2 during its approach toward the corresponding housing of the connector 4 in question.

As seen in FIGS. 2, 3, 4 and 5, the insertion member 8 of the device, which member is without a connexion element, projects perpendicularly relative to one of the faces of said body 7, that is to say parallel to the direction of displacement OZ. This face thus corresponds to the lateral front face 7A of said body. This cantilever arrangement of said member 8 allows an easy mounting of the latter on the body, as well as of the connexion elements on the member itself, and furthermore holds the body 7 away from said connectors.

More particularly, with regard to FIGS. 2 to 6, a plate 24 is provided inside the body 7, being placed approximately in its median plane, that is to say, in relation to the reference system of FIG. 1, parallel to the XOZ plane. The projecting end 24A of the plate 24 emerges from the lateral front face 7A of the body 7 in order to thus carry, by means of removable fixing means 21, the selected insertion member 8.

In this embodiment, the removable fixing means 21, further shown in FIGS. 2, 6 and 7, consist of a tenon-mortise type assembly ensuring that said member 8 may slide along the OZ axis on the plate 24 of the body and of a ball lock, immobilizing the insertion member 8 in position. The tenon 21A of the assembly is formed on a base 8A of said member and has a T-shaped cross section, while the mortise 21B of complementary shape is provided under the lower face 24B of the projecting end 24A of said plate 24.

The locking in position is obtained by means of the ball 21C partially housed in the base 8A of said member so as to project slightly relative to this base, and thus engaging into a corresponding recess 21D provided in the bottom 21B1 of the mortise 21B. This ball 21C is held engaged in the recess 21D by means of a component 21E having a sloping portion 21F on which the ball rests, said component being subjected to the action of a compression spring 21G acting along the OZ axis. It is therefore understood that under the action of the spring 21G, the ball 21C is pushed into the corresponding recess 21D, via the component 21E with the sloping

portion. It is noted that the end 21H of the component 21E, opposite to that subjected to the action of the spring, projects slightly relative to the front face 8B of the insertion member. This arrangement makes it possible, as will be revealed subsequently, to unlock and to dismantle the insertion member 8 from said body 7.

In addition, the grasping means 20 of each member 8 are of the clamp type and for this purpose comprise two jaws 20A and 20B, which are articulated about a spindle 20C parallel to the OZ axis of the reference system and therefore to the sliding motion defined by the tenon-mortise assembly. Referring to FIGS. 1, 6 and 7, one of the jaws 20A is, in this embodiment, stationary and solidly fixed to the base 8A of the insertion member, in such a way that this base 8A and the jaw 20A make up only the one piece, whilst the other jaw 20B is movable and Joined in rotation to the articulation spindle 20C by a peg 20D placed radially as seen in FIG. 7. Each insertion member 8 consists then mainly of two jaws, one of which is solidly fixed to the base and to the articulation spindle. The grasping grips 20E and 20F, provided at the end of the jaws 20A and 20B respectively, are identical and each have the shape of a semi-cylindrical cover. These grips 20E and 20F are parallel to each other and to the OZ axis and they grasp the connexion elements 2, the geometrical characteristics of which correspond of course to those of the selected insertion member. For example, it can be seen in FIG. 6 that the grips of the jaws 20A and 20B hold the rear part 2A of a male pin 2 which is crimped on the bare end of the electrical conductor 3A of a cable 3. The end 3B of this cable is, in addition, guided by the grips of said jaws, by virtue of their elongate shape. The front part 2B of the pin, which is intended to be connected into the corresponding housing of a connector and which is separated from the rear part by a rib 2C, is thus placed strictly parallel along the OZ axis.

The means 20 for grasping each insertion member 8 may be actuated by the control means 22. To that end, and referring in particular to FIGS. 3 and 6, it can be seen that the means 22 comprise an electric motor 22A Joined up to the directing unit 6 and capable of driving, through an angular arc, the articulation spindle 20C of said grasping means via an intermediate shaft 22B and a friction mechanism 22C. More particularly, the electric motor 22A is of the step-type and is fixed to the bottom 7C of the body 7. The end 22F of the intermediate shaft 22B is coupled to the output shaft 22D of said motor, by means of a fluted Joint 22E, the other end 22G of the intermediate shaft interacting with the articulation spindle 20C by means of the friction mechanism. The output shaft 22D of the motor, the intermediate shaft 22B and the articulation spindle 20C are aligned and coaxial, parallel to the OZ axis of the reference system. As regards the mechanism 22C, it comprises two disks 22H, one of which is associated with the other end 22G of the intermediate shaft, and the other being fixed to the widened corresponding end 20C1 of the articulation spindle 20C. The two disks 22H are pressed against each other by means of a compression spring 22I provided between the motor 22A and a flange 22J of the intermediate shaft, in such a way that the latter is constantly pressed toward the articulation spindle 20C of said grasping means.

As seen in FIGS. 6 and 7, the movable jaw 20B and the stationary jaw 20A are held in the closed position by means of a torsional spring 25, one of the ends of which is joined to the stationary jaw 20A, while the other end is fixed to the friction disk 22H which is solidly fixed to the articulation spindle 20C of said grasping means, to which the movable jaw 20B is solidly fixed by means of the peg 20D. The electric step motor 22A then assumes a first position, in which the grips 20E and 20F of said jaws are pressed against each other. It is therefore understood that, when the motor 22A is actuated, the articulation spindle 20C is driven through a predetermined angular arc, by means of the intermediate shaft 22B and the friction disks 22H, the transmitted force of which exceeds that of the torsional spring. The movable jaw 20B connected in rotation with the spindle 20C pivots with the latter, such that its grip 20F moves away from the grip 20E of the stationary jaw 20A. The motor 22A then assumes a second position, in which the jaws make it possible to release the connexion element 2, then connected in the connector housing, or to grasp one of the connexion elements of another cable provided on the conveying means.

Referring in particular to FIGS. 3, 4 and 5, it can be seen that the means 23, making it possible to protect the connexion element 2 grasped by the insertion member 8, comprise two identical movable shields 23A, 10 placed symmetrically on either side of said insertion member 8 locked on the plate 24 by the fixing means 21. More particularly, the shields 23A have, at their front ends, a shell shape 23B making it possible to cover the connexion element 2 by the insertion member 8, as will be seen in particular with regard to FIG. 12 to 14. The rear ends of the shields 23A end in the shape of flat wings 23C which are applied under the lower face of said plate 24. The shield wings 23C are then joined to the plate by means of spindles 23D, two per wing, respectively passing through two slots 24C formed in the plate. These slots 24C are symmetrical to each other in relation to the median longitudinal axis of the plate, parallel to the OZ axis, and converge in the direction of the front face 7A of the body 7, that is to say toward the insertion member 8.

The displacement of the shields in the slots of the plate is carried out by actuating means, such as a jack 23E fixed to the upper face 24D of the plate 24 and controlled by the programable directing unit 6. The rod of the Jack 23E carries at its end a carriage 23F which is joined up to the wings 23C of the shields 23A via one of the two spindles 23D of each wing, passing through the slots 24C, and which is mounted so as to slide in a groove 24E formed in the plate 24 along its median longitudinal axis, parallel to the OZ axis. The slots 24C, which are advantageously converging, thus enable the shields 23A to pass, by means of the spindles 23D which follow the path imposed by the slots, from a retracted open position away from said insertion member 8 (FIGS. 3 to 5), to a closed position (FIGS. 12 to 14) in which said shells 23B cover the connexion element, under the action of the Jack 23E pushing the carriage 23F which, in turn, displaces the shields by means of the spindles 23D.

It will also be noted that the shields 23A, with the exception of their front ends 23B, and the control jack 23E are advantageously housed inside the body 7, thus being protected therein, in the same way as the control means 22.

In addition, FIG. 9 shows one of the two boxes 15A in the compartments 15B of which the various available insertion members 8 are housed, via supports 15C respectively. The dimensional characteristics of the grasping grips 20E, 20F are different for each member and are consequently adapted to the dimensional characteristics of the various connexion elements 2 to be connected. Each insertion member 8 is held by its support 15C, the external parallelepipedal shape of which corresponds to the internal shape of the compartment 15B, and which is mounted in the latter along a direction parallel to the OZ axis. Referring more particularly to FIG. 10 which shows one of the supports, it can be seen that two arms 15D, spaced apart and parallel to one another, project

relative to the visible front face 15E of each support 15C, parallel to the OZ axis. The insertion member 8, the front face 8A of which is then turned toward the shoulders 15F provided symmetrically in the arms 15D, is able to be inserted and held between these two arms. To that end, these arms are mounted so as to slide by means of their rear ends, in a groove 15G having a cross-shaped cross section and made parallel to the OX axis of the reference system in the front face 15E of the support. The arms 15D are thus properly Joined to the support and may in addition slide in opposite directions in the groove 15G, by virtue of motor means which are not shown. The two arms move toward one another, under the action of the motor means, in order to hold the insertion member 8 tightly in position.

In addition, it can be seen in this FIG. 10 that a controllable piston 15H also projects relative to the front face 15H of each support, above and between the two arms 15D. The arrangement of this piston 15H is such that, when the insertion member is carried by the arms 15D, the end 21H of the component 21E faces this piston, as will be seen more particularly with regard to Figures 11A to 11C.

The operation of the automatic connexion machine 1, equipped with the two devices 5, will now be described.

Firstly, it has been assumed in FIG. 1 that cables 3 are already connected by means of their connexion elements 2 in the specific connectors 4. These connexions have been carried out by the devices, as a function of the information contained and issued by the directing unit 6, which devices thus simultaneously deal with the two connexion elements equipping each cable respectively. In order to avoid the connected cables becoming entangled with each other, a grid 18 is fixed to the base 10A of the frame just below the support 17 of the connectors 4. The cables 3 can thus be better organized.

It has been furthermore assumed that the next operation cycle of the machine consists in connecting the pins 2.1 and 2.2 equipping the cable 3.1, which is conveyed by the endless conveyor 12A and the pins of which are placed within the field of vision of the cameras 14A. These cameras make it possible to accurately detect the position of the pins 2.1 and 2.2 so that the directing unit 6 may control the grasping of said pins by the clamps 16, in order to withdraw them from the clamps 12C and to stretch the ends of the cable 3.1 on which said pins are crimped. Depending on the order in which the cables arrive, the directing unit 6 determines, by means of the data stored in its memory, on the one hand, the two connectors 4 intended to receive the two pins 2.1 and 2.2 respectively and, on the other hand, the insertion members 8 to be mounted into the two bodies 7 of said devices, these members depending on the geometrical characteristics of the pins 2.1 and 2.2.

The two insertion members 8, having been used to plug the pins of the preceding cable, have been, for example, put back in the corresponding supports 15C of the boxes by means of the displacements of the movable parts 11. The mounting of the selected insertion member 8 into its body will be described below with regard to FIGS. 11A, 11B and 11C. Needless to say, in the event of one or both insertion members used previously corresponding to both following pins to be grasped, the devices 5, carried and displaced by the movable parts 11, position themselves directly above the clamps 16 so as to grasp the ends of the cable.

As shown in FIG. 11A, the body 7 of each device is conveyed, by means of suitable displacements along the OX, OY and OZ axes of the corresponding movable part 11, to face the insertion member 8 to be used as a function of the characteristics of the pins. Thus, the mortise 21B provided in the plate 24 of the body faces the tenon 21A of the insertion member, and the axis which is common to the motor 22A and to the intermediate shaft 22B is coaxial with the articulation spindle 20C. It will also be noted that the spring 22I is then relaxed, pushing the intermediate shaft 22B slightly away from the output shaft 22D of the step motor 22A.

As regards the insertion member 8, it is clamped by the two arms 15D of the support 15C, and the piston 15H is in the projecting position, such that the component 21E of the fixing means 21 compresses the spring 21G, thereby causing the ball 21C to move downward as a result of the displacement of the sloping portion 21F. The ball 21C is then embedded in the base 8A or the tenon 21A of the insertion member. In addition, the jaws 20A and 20B of the grasping means are in the closed position under the action of the torsional spring 25.

The body 7 via the seat 11C of its movable part 11, is displaced along the OZ axis (FIG. 11A to FIG. 11B), in such a way that the mortise 21B slides on the tenon 21A of the member.

At the same time, the disk 22H of the friction mechanism, joined to the intermediate shaft 22B, presses against the disk 22H joined to the articulation spindle 20C. The displacement along the OZ axis of said body continues until the spring 22I is compressed by the retreat of the intermediate shaft 22B, since the insertion member 8 is held in position by the arms 15D. The shaft 22B is able to slide on the output shaft 22D of the motor 22A by means of the fluted joint 22E. In the position shown in FIG. 11B, it can be seen that the engagement of the tenon 21A of the member 8 in the mortise 21B of the body 7 is such that the ball 21C has passed over the recess 21D provided in the plate 24 by virtue of the projecting position of said piston 15H. At this time, this piston is controlled in order to pass to its retracted position, then the arms 15D release their pressure on the insertion member which is held by the intermediate tenon-mortise Joint on the body 7.

The seat 11C of the movable par 11 retreats in the opposite direction along the OZ axis, such that the insertion member 8 is then pushed, under the action of the spring 22I, toward the outside until the point when the ball 21C engages in the recess 21D of the plate 24 under the action of the spring 21G which forces the ball to project outward by means of the sloping portion of the component 21E.

The devices 5, the insertion members of which are locked to the respective bodies, are displaced toward the pins 2.1 and 2.2 which are crimped on the electrical conductor of the cable 3.1, on instructions sent by the directing unit 6 to the corresponding movable pars 11. Beforehand, the jaws 20A and 20B of each insertion member 8 pass from the closed position to the open position, as illustrated in regard of FIG. 8. To that end, the electric step motor 22A, controlled by the unit 6, drives, by means of the intermediate shaft 22B and the friction disks 22H, the articulation spindle 20C in rotation through a suitable angle, hereby moving the grip 20F of the movable jaw 20B away from the grip 20E of the stationary jaw 20A. By means of the information supplied by the cameras 14A relating to the actual positions of the pins 2.1 and 2.2, the directing unit instructs each device 5 which thus positions itself above the corresponding pin of the cable, which pin is then grasped by the jaws of the grasping means 20.

The movable jaw 20B of each insertion member passes to the closed position under the action of the control means 22, such that the grips 20E and 20F of the grasping means 20 grasp -their allocated respective pins 2.1 and 2.2, in the

manner shown in FIG. 6. The clamps 16, as well as the clamps 12C of the conveyor 12A, controlled by the directing unit 6, then release the ends of the cable 3.1, fitted with the pins 2.1 and 2.2.

The two devices 5 are then displaced along the axes of the reference system toward the two connectors 4 to be connected, such as, for example, the connectors 4.1 and 4.2 shown in FIGS. 15A and 15B respectively. Prior to the insertion phase which will be described subsequently with regard to these figures, the means 23 for protecting each device 5 are employed under the control of the-unit 6 because of the abovementioned risks of damaging the pins. To that end, as can be seen in FIGS. 12, 13 and 14, as soon as the operation cycle reaches the phase in which the pins approach, along the OZ axis, the corresponding connector housings, the jack 23E of each device is actuated such that the spindles 23D Joining up the carriage 23F to the two retractable shields 23A slide into the slots 24C of the plate and, by virtue of the converging shape of said slots, drive the shields toward each other until the shells 23B of these shields surround the pin held by the grips of the grasping means. Each pin is thus efficiently protected by the shield shells, which force their way, along the OZ axis, through the already connected cables 3. When the approach phase is completed, the rod of each Jack 23E is brought back to the withdrawn position, resulting in the retreat of the carriage 23F and of the shields 23A guided, by means of the spindles 23D, through the slots 24C, so as to move apart and to retreat away from the insertion member 8. The shields are thus returned to the retracted withdrawn position.

Each device 5 is then controlled along the OZ axis so as to carry out the connexion proper. More particularly, as shown in FIGS. 15A and 15B, it is assumed, by way of example, that the connectors 4.1 and 4.2 are of the circular type, and male and female respectively. Thus, it can be seen in FIG. 15A that one of the male pins 2 is already inserted in its housing 4A while being held there axially, in the ordinary manner, by the elastic tabs 4B1 of a socket 4B which forces the rib 2C of the pin against the shoulder 4C provided in each housing 4A of the connector. The insertion member 8 of the device is in the course of being displaced along the OZ axis, such that, at this moment, the male pin 2.1 provided at this end of the cable 3.1 is practically engaged in its housing, the rib 2.1C moving the elastic tabs of the socket 4B apart before this socket axially holds the pin 2.1. The front of the grips 20E and 20F is partially engaged in the housing. A check on the force throughout the insertion phase makes it possible to detect the instant when the pin comes to bear against the shoulder 4C of the housing. The socket 4B then locks the corresponding pin. The device 5 is brought back, along the OZ axis but in the opposite direction, out of the connector. As soon as the insertion member 8 is at a sufficient distance, the step motor 22A, controlling the grasping means, is actuated through a given opening angle, simultaneously causing the intermediate shaft 22B and the friction disks 22H to rotate, which causes the movable jaw 20B to move away from the stationary jaw 20A, and thus frees the corresponding end of the cable from said insertion member 8.

The connexion of the female pin 2.2, equipping the other end of the cable 3.1, into the corresponding housing of the connector 4.2 is carried out in the same manner, as is the freeing of this cable end from said insertion member 8.

At this stage, a new connexion cycle can start. To that end, the two devices 5 are displaced, by means of the parts 11, toward the conveyor 12A in order to deal with a new cable 3 or, if the connexion elements 2 are different from those dealt with previously, toward the storage locations 15A, in order to change the insertion members 8.

When all the cables are connected, all the connectors 4 thus equipped are sent to a so-called "routing" machine, which is intended to shape the cabling bundle 30 obtained automatically, such as that shown by way of example in FIG. 16.

I claim:

1. A machine for automatically inserting connexion elements of electrical conductors of cables into connector housings, which comprises:

(a) at least two connecting devices (5) each of which includes (i) a body (7) which can be displaced toward corresponding housing of a connector (4), (ii) at least one insertion member (8) provided with means (20) for grasping a connexion element (2) to be inserted into the corresponding housing (4A) of the connector, (iii) means (21) for fixing said at least one insertion member to said body, allowing locking or unlocking of said at least one insertion relative to said body, (iv) means (22) for controlling said grasping means (20), associated with said body and capable of assuming, when said insertion member (8) is locked, a first position, in which said grasping means (20) holds said connexion element (2) and enables it to be inserted into the corresponding housing of the connector, and a second position, in which the grasping means releases said connexion element which is then connected in the connector housing, (v) said fixing means (21) being removable and comprising a tenon (21A) and mortise (21B) assembly allowing said insertion member (8) to slide on the body (7), and a ball lock (21C) enabling the insertion member to be immobilized in position relative to said body, said at least two connecting devices (5) intended to deal respectively with the two connexion elements (2) provided at the ends of each cable (3), the body (7) of each device intended to carry said insertion member (8), being capable of being displaced, relative to a frame (10) of the machine, along the OX, OY and OZ axes of an orthonormal reference system;

(b) a plurality of connectors (4), the housings (4A) of which are intended to receive the corresponding connexion elements, and which are placed on said frame;

(c) means (14) for visualizing the positions of the connexion elements (2) equipping the respective ends of each cable;

(d) an area (15) for storing the various insertion members which are capable of being locked to said respective bodies, and which are selected as a function of the geometrical characteristics of said connexion elements to be connected; and

(e) a programable directing unit (6) containing the information relating to the various connexions to be carried out depending on the connexion elements (2) provided at the end of each cable (3), and on the housings (4A) of said connectors (4), as well as the types of insertion members (8) to be selected as a function of the connexion elements to be connected, and to which unit are joined up the means (22) for controlling the means (20) for grasping each selected member, and the displacements of each body (7) along the OX, OY and OZ aces of said reference system.

2. A machine as claimed in the preceding claim 1, which additionally comprises means (12) for successively conveying said cables (3) to be connected, equipped with said connexion elements (2), in front of said visualizing means

(14), said conveying means being joined to said programmable directing unit (6).

3. The machine as claimed in claim 2, wherein said conveying means (12) comprises an endless conveyor (12A) on which the two ends of each cable (3), equipped with said connexion elements, are placed, via clamps (12C) associated with the conveyor.

4. The machine as claimed in claim 1, wherein said body (7) of each device (5) is mounted on a movable part (11) attached to the frame (10), each of said movable parts (11) comprising a crosspiece (11A) which is capable of sliding, along the OX axis of said reference system, on at least one beam (10D) solidly fixed to said frame, a carriage (11B) mounted so as to slide along the OY axis of said reference system on said crosspiece, and a seat (11C) carrying said body (7) and associated with said carriage (11B) so as to slide along the OZ axis of said reference system, said housings (4A) of the connectors (4) being placed along the OZ axis of said reference system.

5. The machine as claimed in claim 1, wherein said storage area (15) consists of two identical boxed (15A) in the compartments (15B) of which the various insertion members (8) are housed, via supports (15C), each support (15C) being provided with controllable arms (15D) for holding the insertion member and with a piston (15H), placed so that it projects from the support and against said removable fixing means (21).

6. The machine as claimed in claim 1, wherein said visualizing means (14) comprise two cameras (14A) associated with the frame (10) and under which the two ends (3A) of each cable (3), provided with said connexion elements (2), come to a standstill.

* * * * *

United States Patent [19]

Suzuki et al.

[11] **4,440,053**

[45] **Apr. 3, 1984**

[54] **WIRE-LAYING HEAD**

[75] Inventors: **Yoshitsugu Suzuki, Mishima; Syogo Iizuka, Gotenba; Shigeo Kajiyama, Shizuoka; Kenji Usui, Gotenba; Masahiro Kobayashi, Susono, all of Japan**

[73] Assignee: **Yazaki Corp., Tokyo, Japan**

[21] Appl. No.: **389,915**

[22] Filed: **Jun. 18, 1982**

Related U.S. Application Data

[62] Division of Ser. No. 223,233, Jan. 8, 1981, Pat. No. 4,363,165, which is a division of Ser. No. 80,682, Oct. 1, 1979.

[30] **Foreign Application Priority Data**

Sep. 29, 1978	[JP]	Japan	53-120280
Nov. 20, 1978	[JP]	Japan	53-142212
Nov. 20, 1978	[JP]	Japan	53-142213

[51] **Int. Cl.**³ **B26D 5/20**

[52] **U.S. Cl.** ..... **83/282**; 83/87; 83/580; 29/564.6; 29/861; 140/93 R

[58] **Field of Search** ..... 140/93 R, 92.1; 29/564.1, 564.6, 564.8, 759, 760, 861, 863, 865, 866; 83/87, 282, 580

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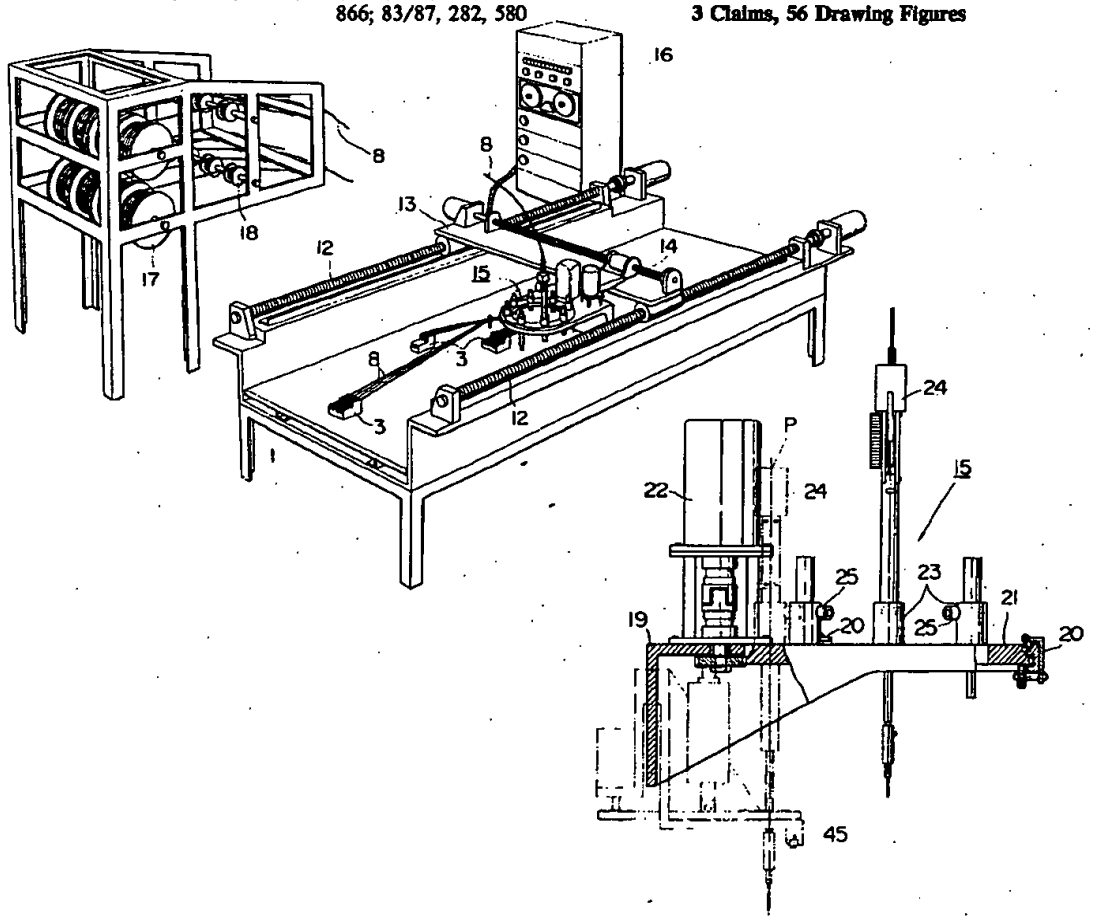
Primary Examiner—Francis S. Husar
Assistant Examiner—Linda McLaughlin
Attorney, Agent, or Firm—Lackenbach, Siegel, Marzullo, Presta & Aronson

[57] **ABSTRACT**

A wire harness manufactured by a new method and a new apparatus is provided. A covered wire paid out from a selected one of reels is extended in a predetermined lay-out and fixed. The thus fixed wire is cut-off from the reel. Then, another wire is paid out from another reel for arranging it in a juxtaposing relation to the previously laid-out wire and cut off from the reel. After repeating the above steps, the arranged wires are tied up to form a wire harness. There is also provided a device which puts the above method into practice, thereby reducing complicated assorting work involved in the manufacture of a wire harness. A method and a device for automatically uncovering end portions of each wire of the wire harness and attaching terminals thereto are also provided to greatly increasing the productivity.

3 Claims, 56 Drawing Figures



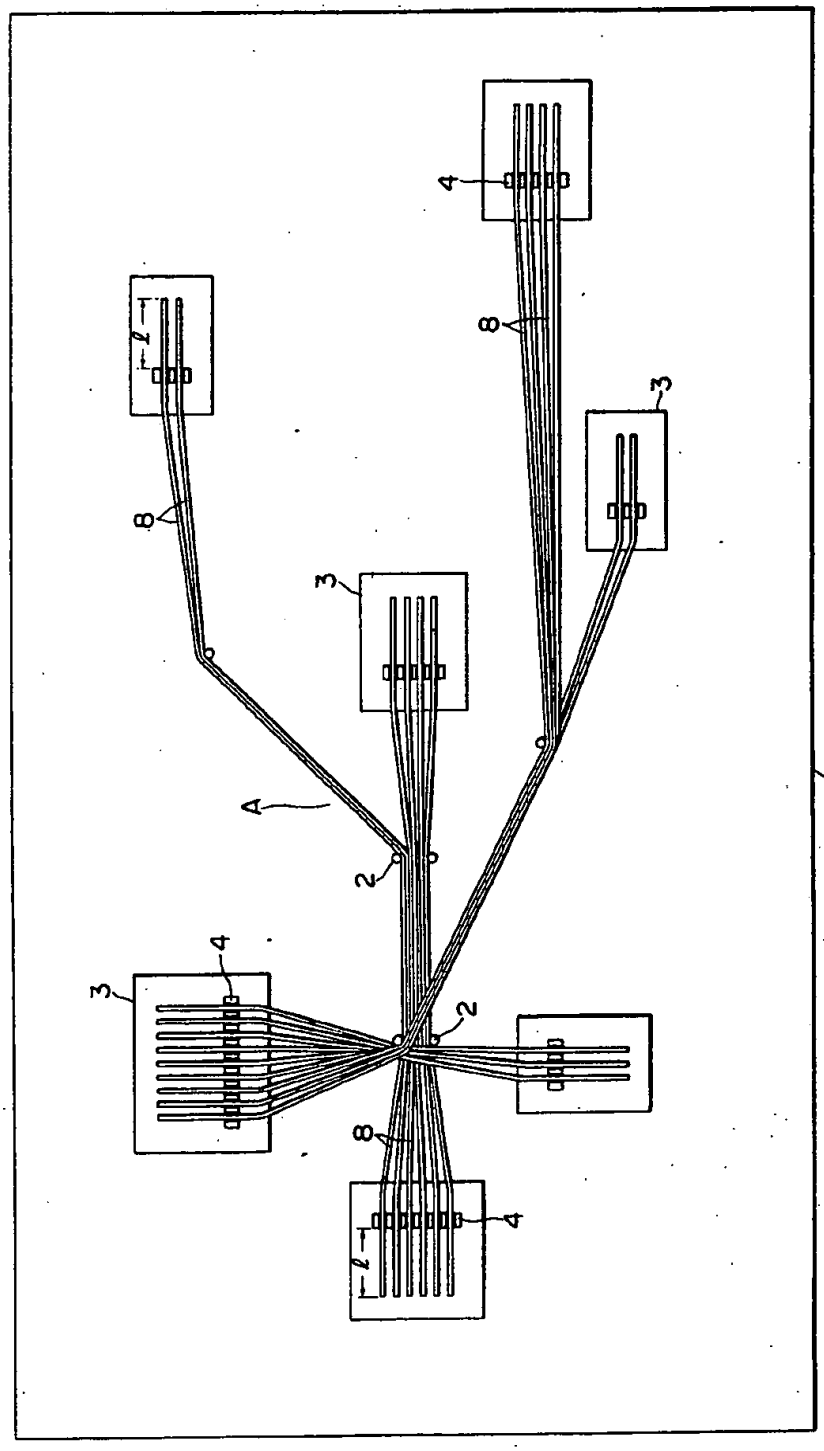


FIG. 1-A

FIG. I-B

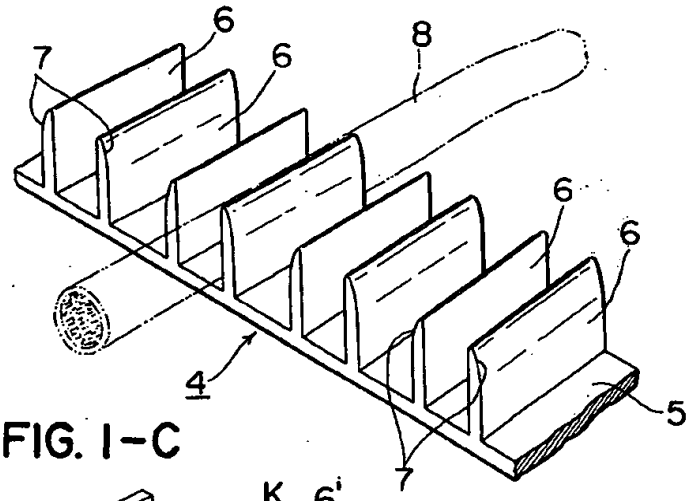


FIG. I-C

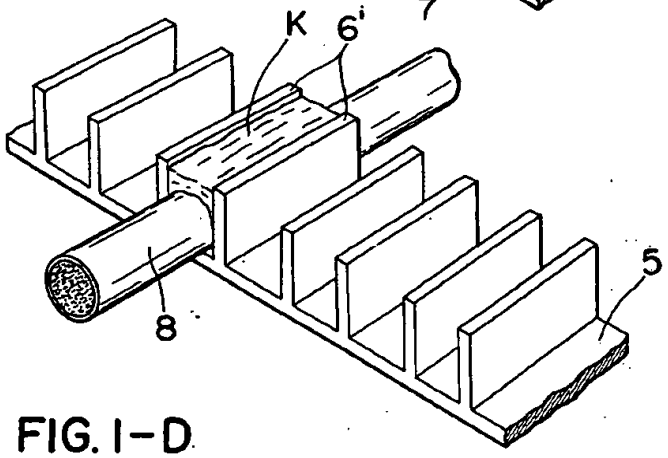
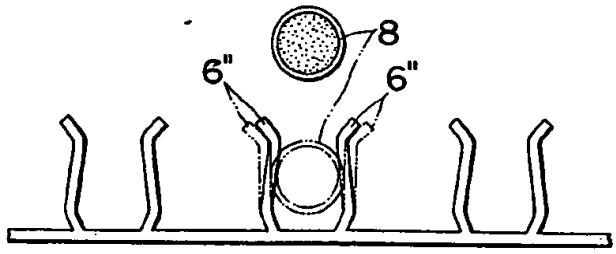


FIG. I-D



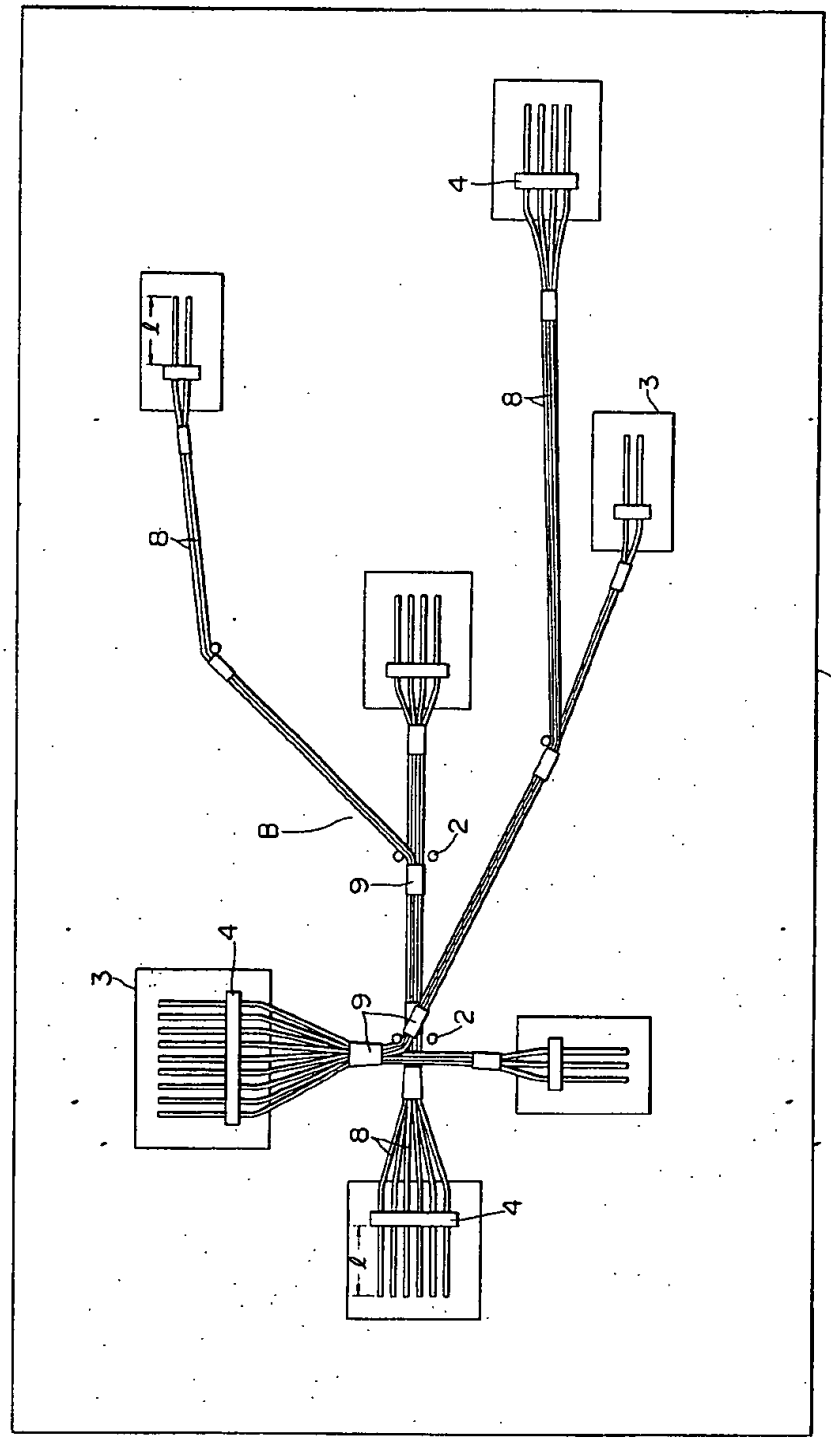


FIG. 2

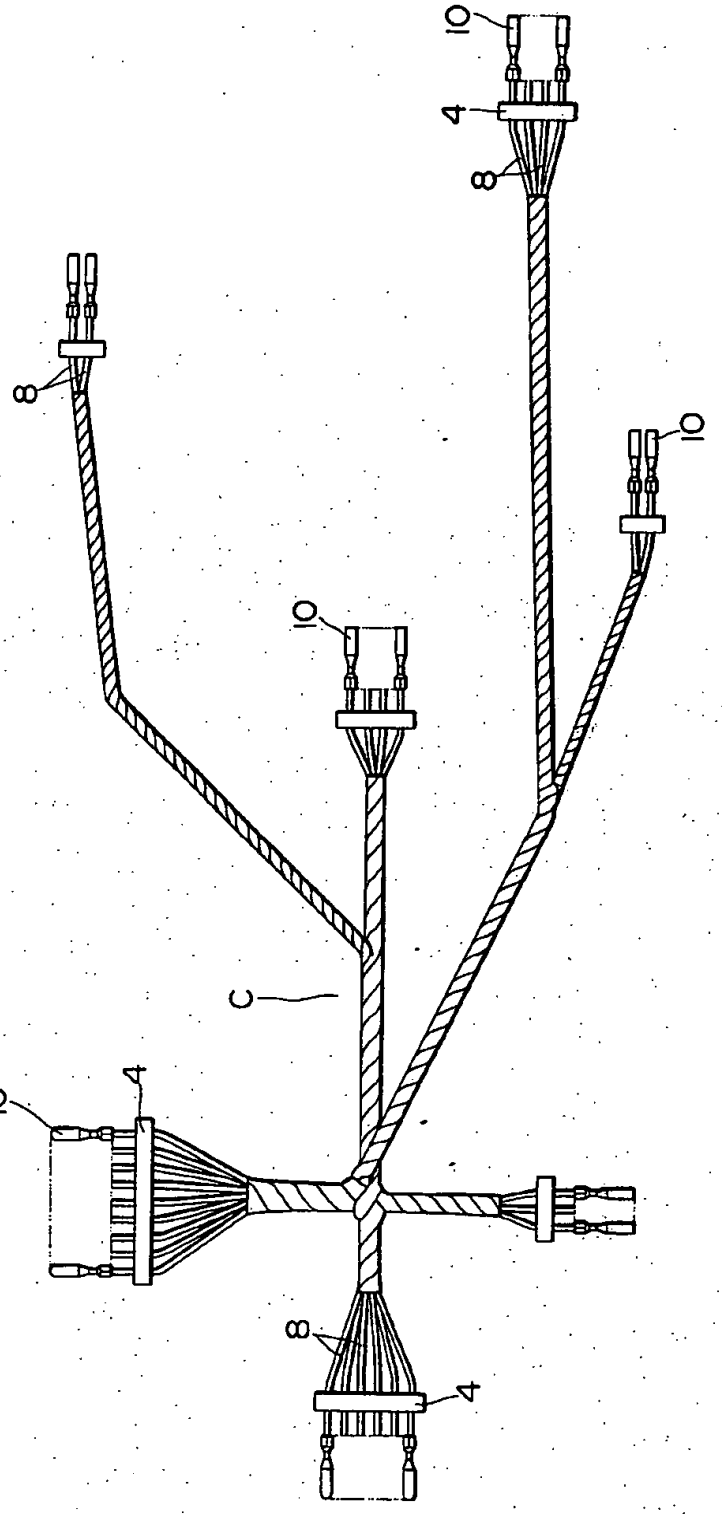


FIG. 3

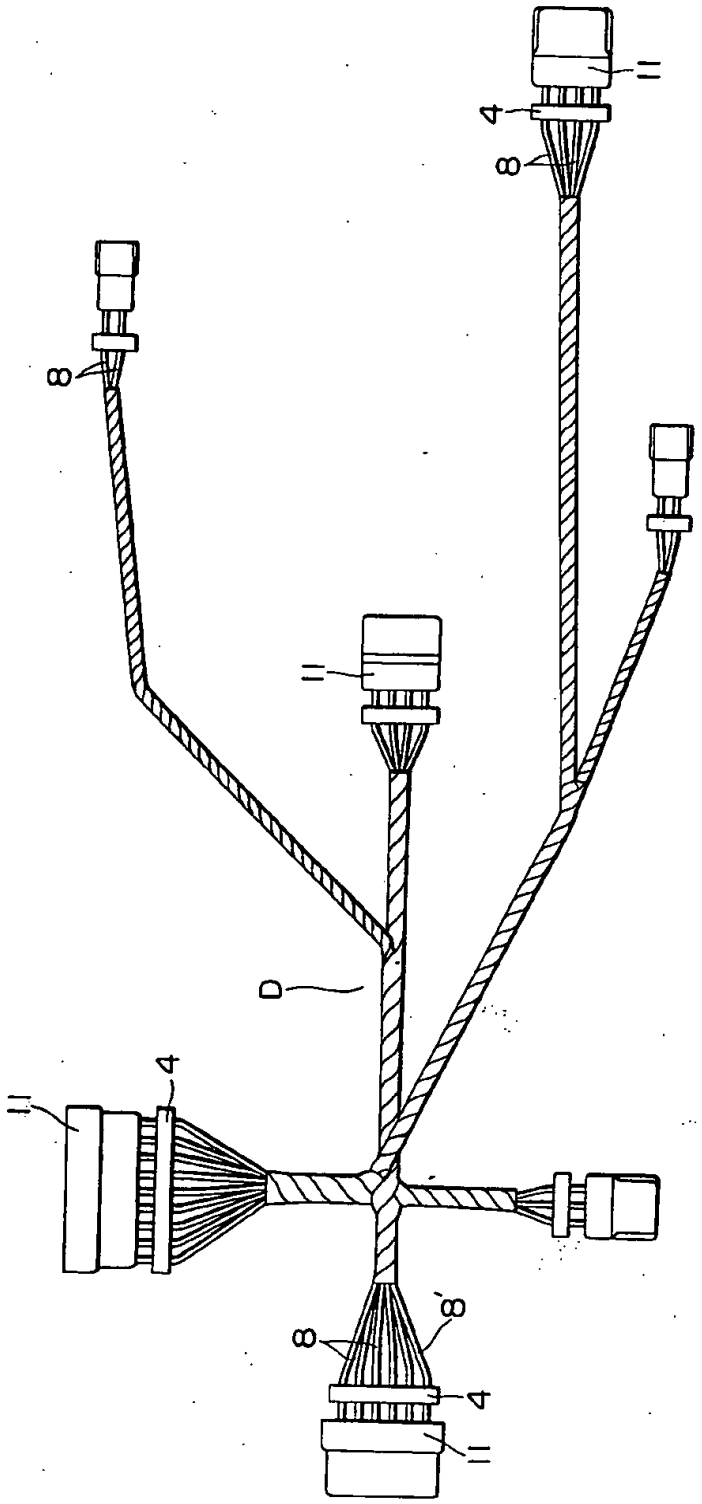


FIG. 4

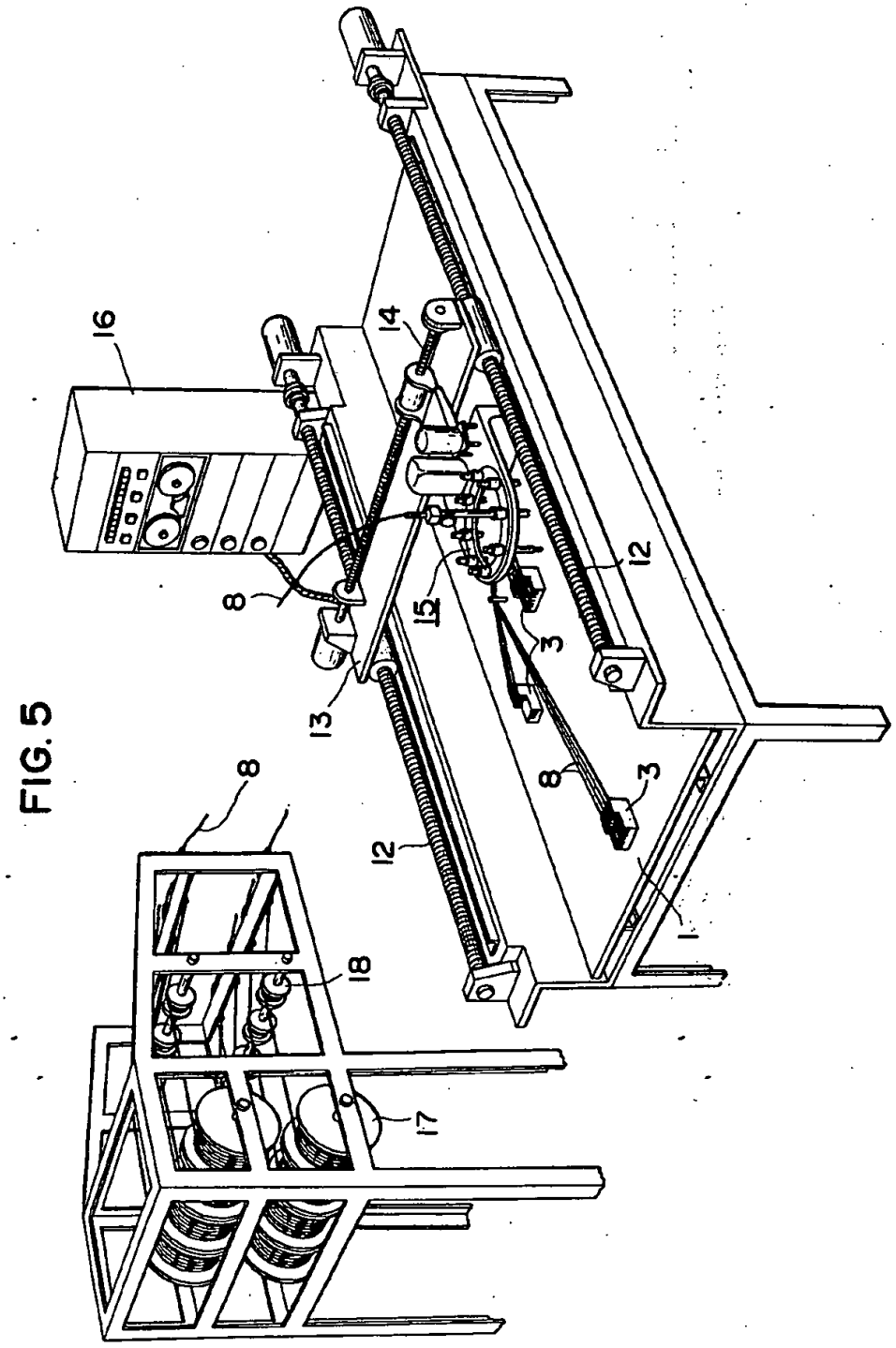


FIG. 5

FIG. 6

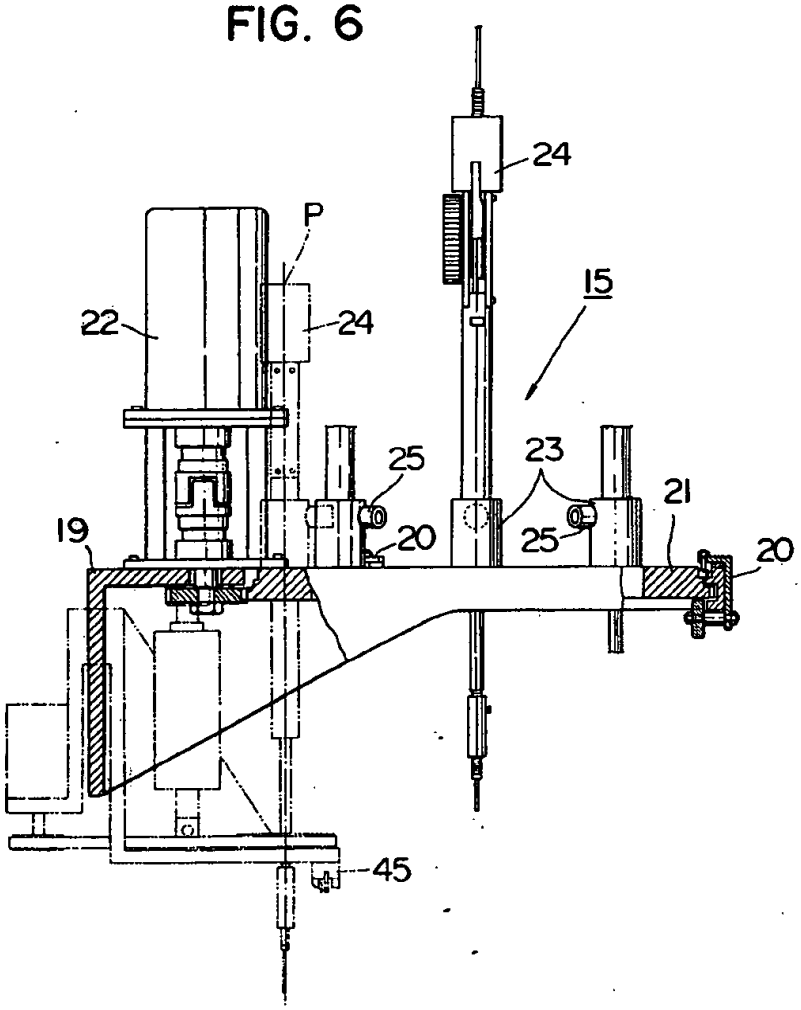


FIG. 7

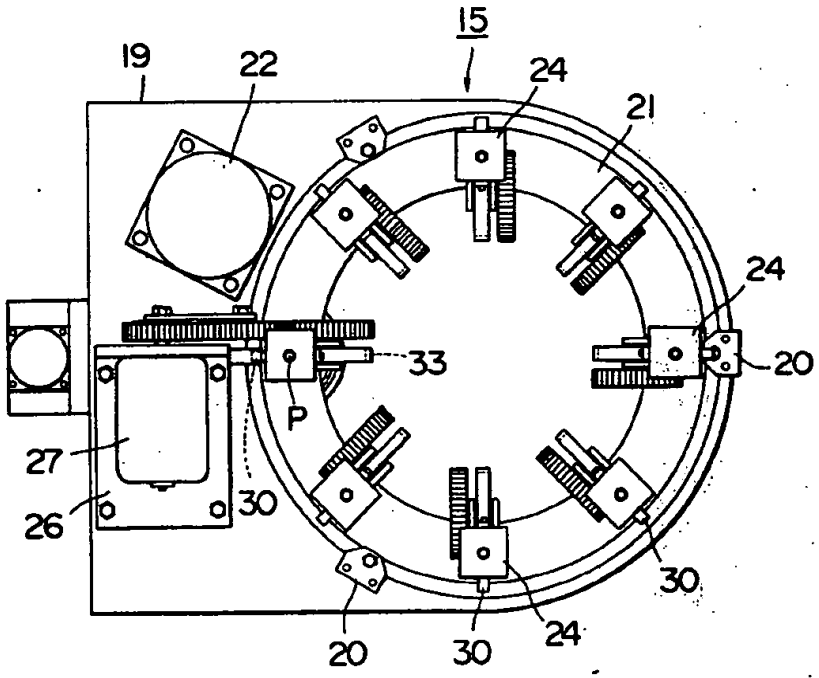


FIG. 8

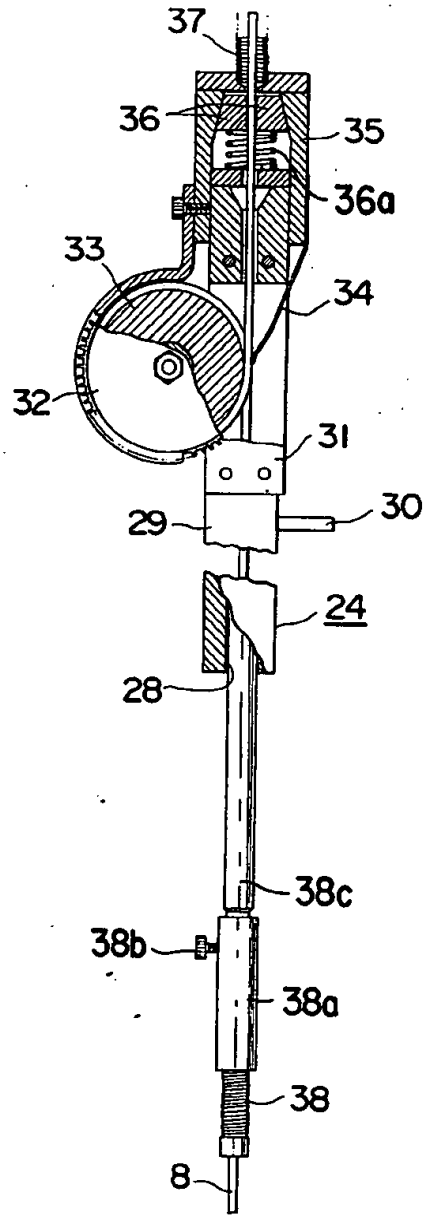


FIG. 9

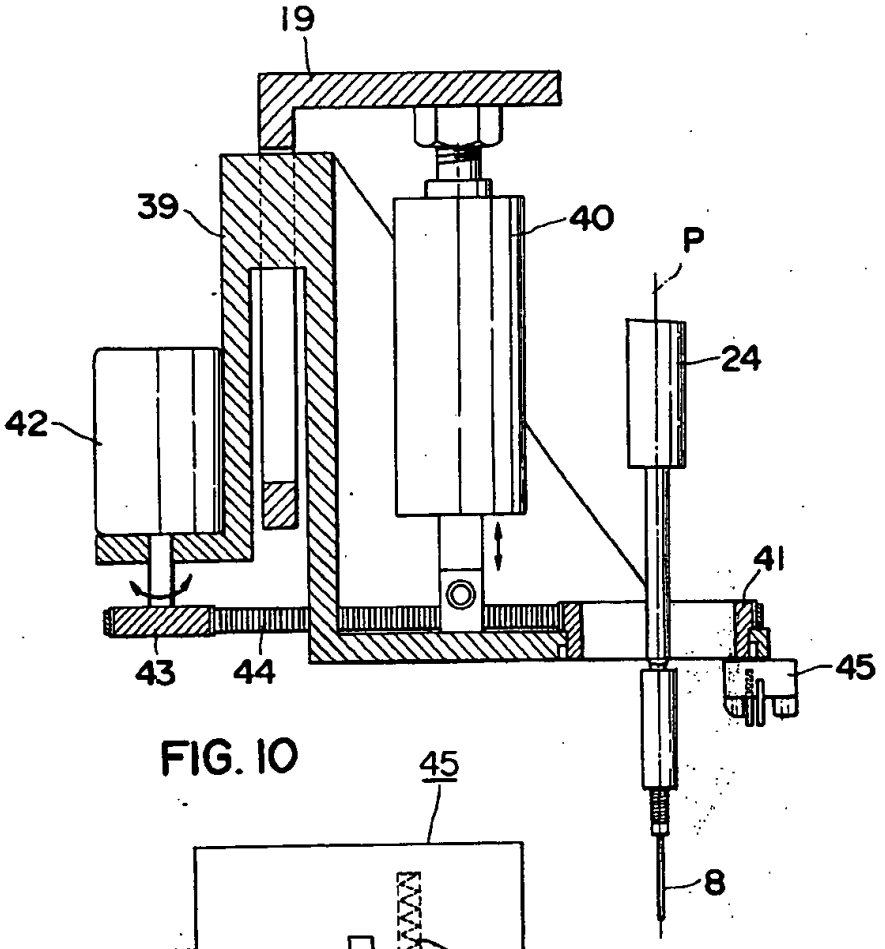


FIG. 10

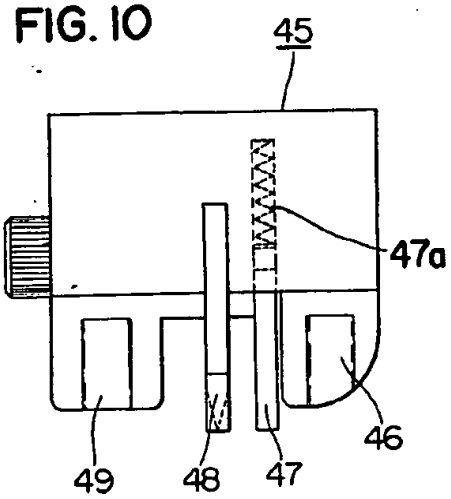


FIG. 11

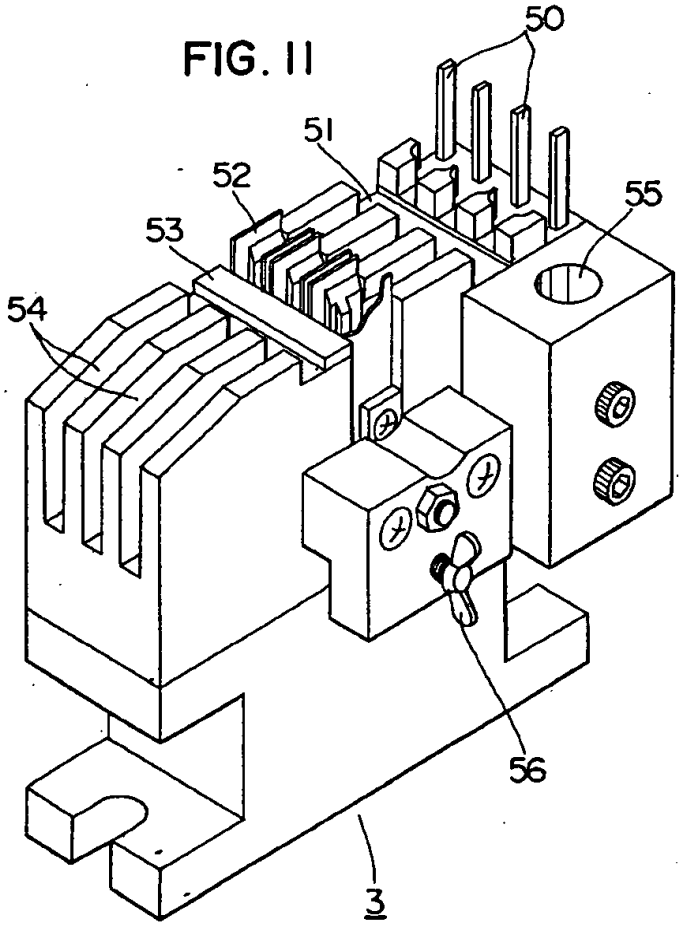


FIG. 12-B

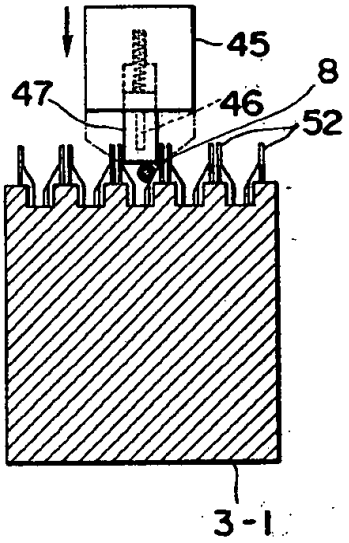


FIG. 12-A

FIG. 12-C

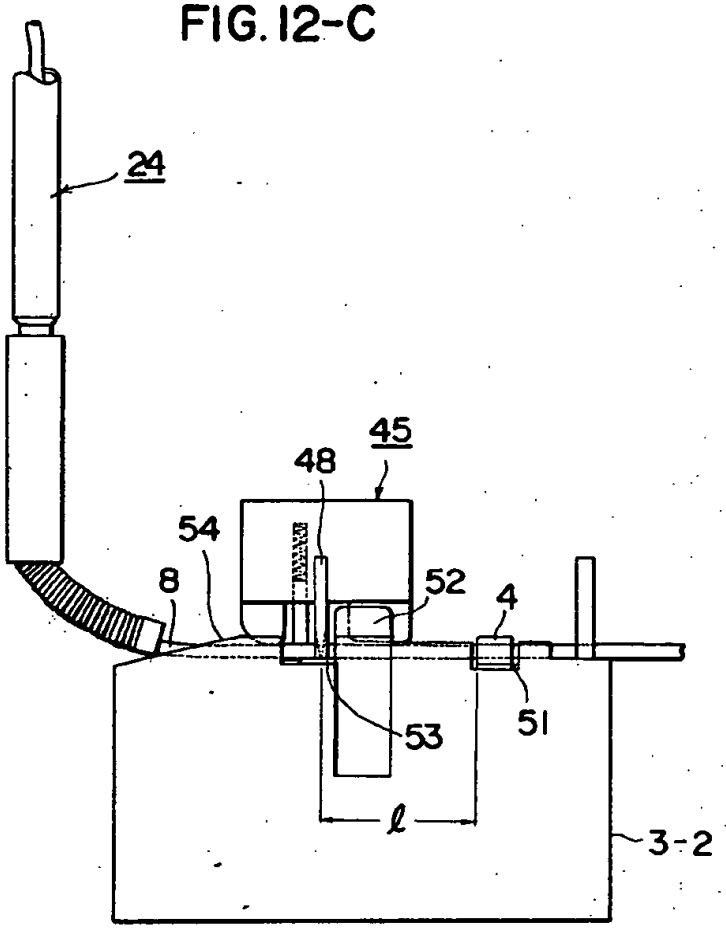


FIG. 13-A

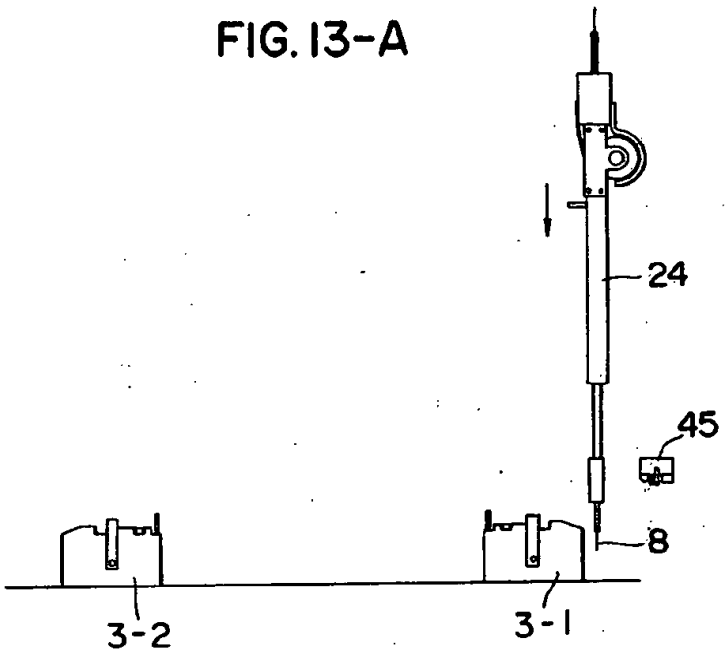


FIG. 13-B

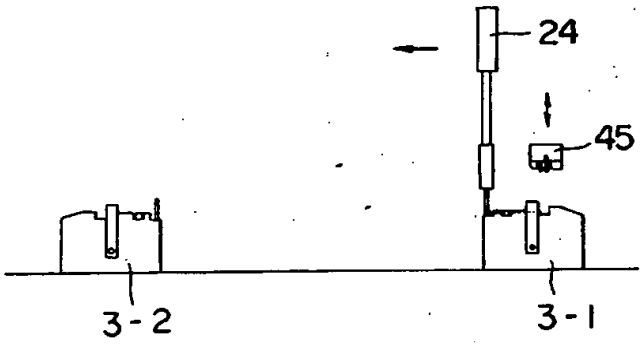


FIG.13-C

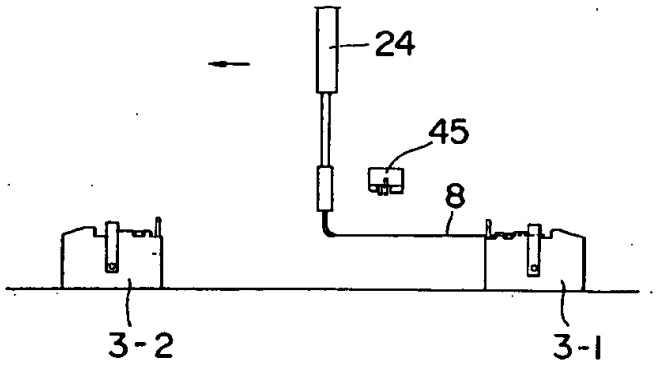


FIG.13-D

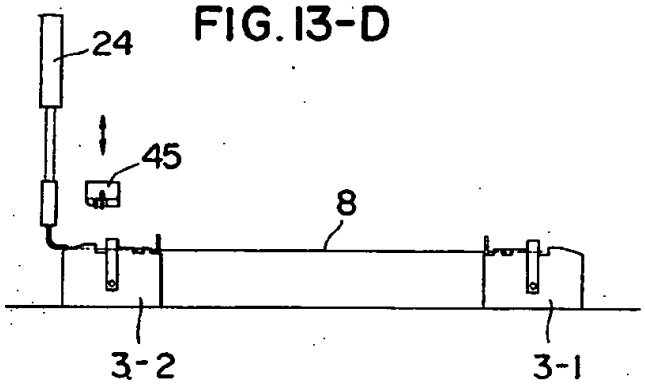


FIG.13-E

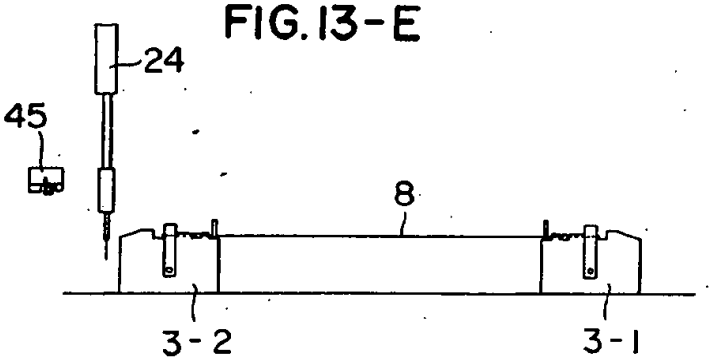


FIG. 14-A

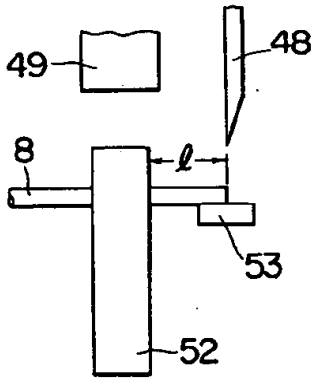


FIG. 14-B

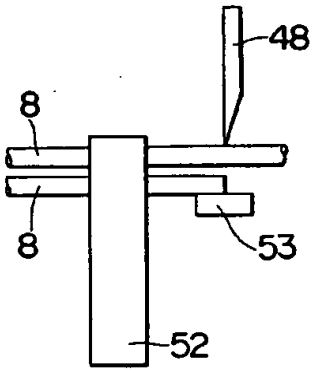


FIG. 15-A

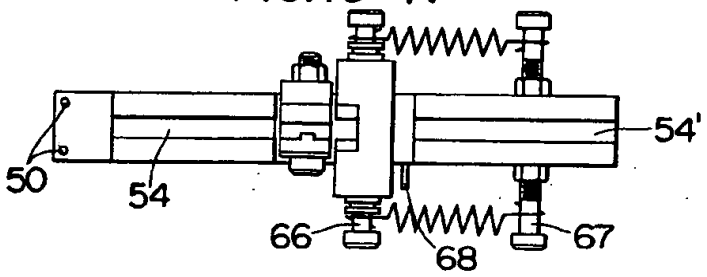


FIG. 15-B

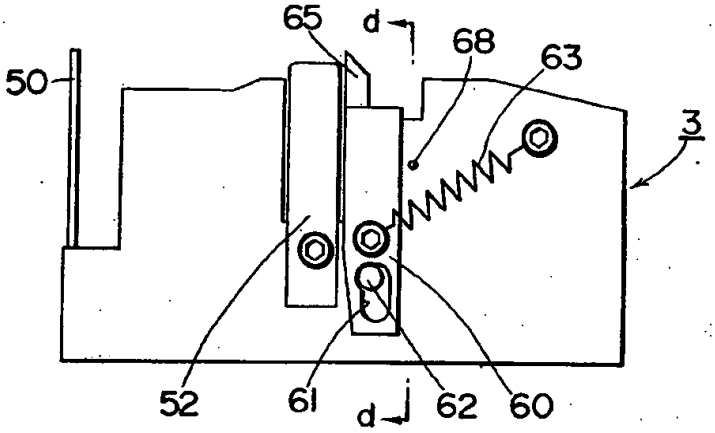


FIG. 15-C

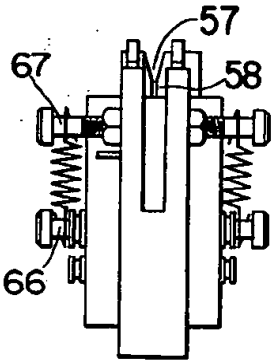


FIG. 15-D

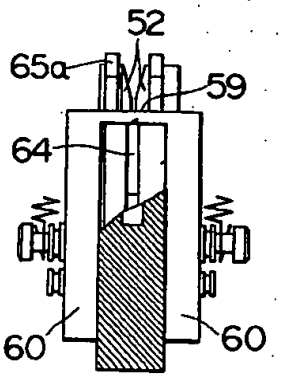


FIG. 16-A

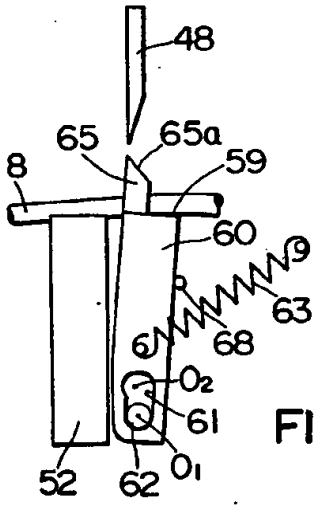


FIG. 16-B

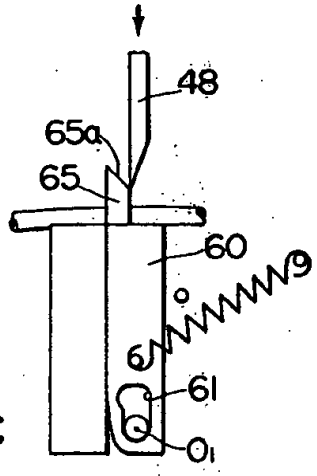


FIG. 16-C

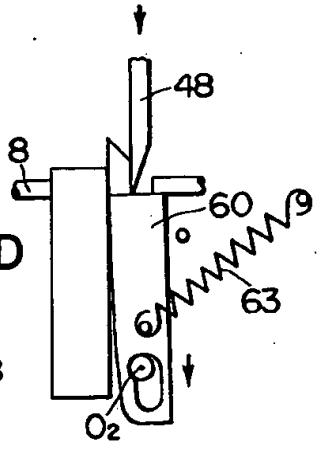


FIG. 16-D

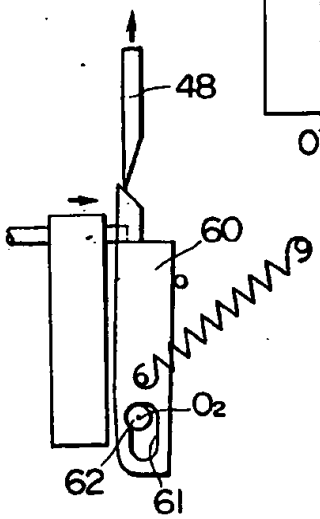
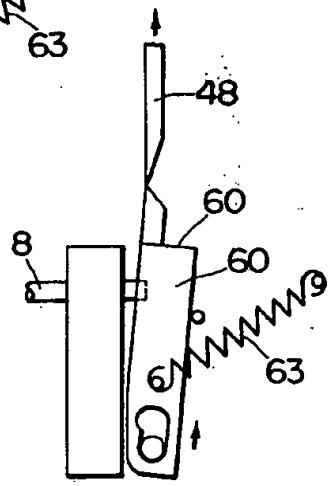


FIG. 16-E



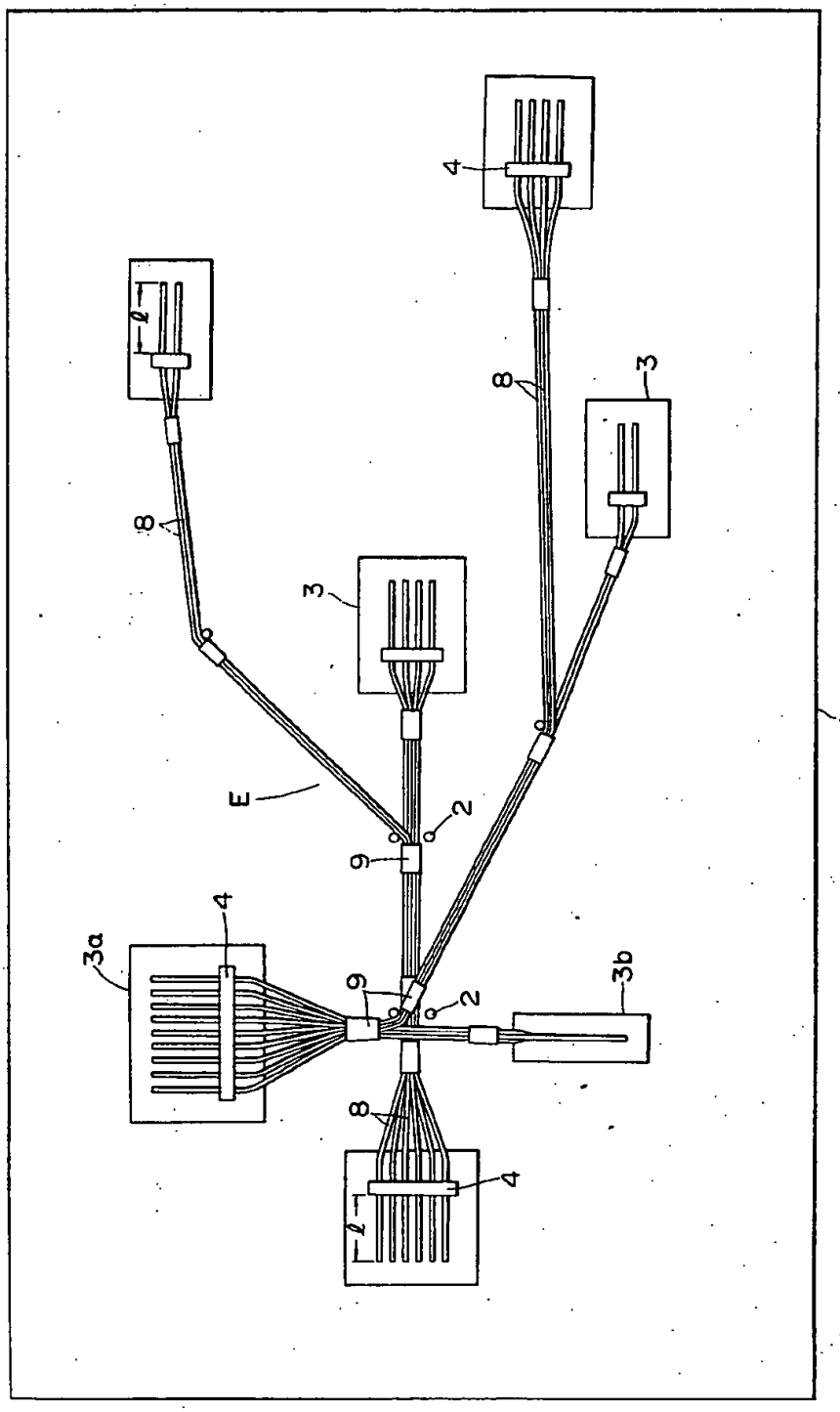


FIG. 17

FIG. 18-A

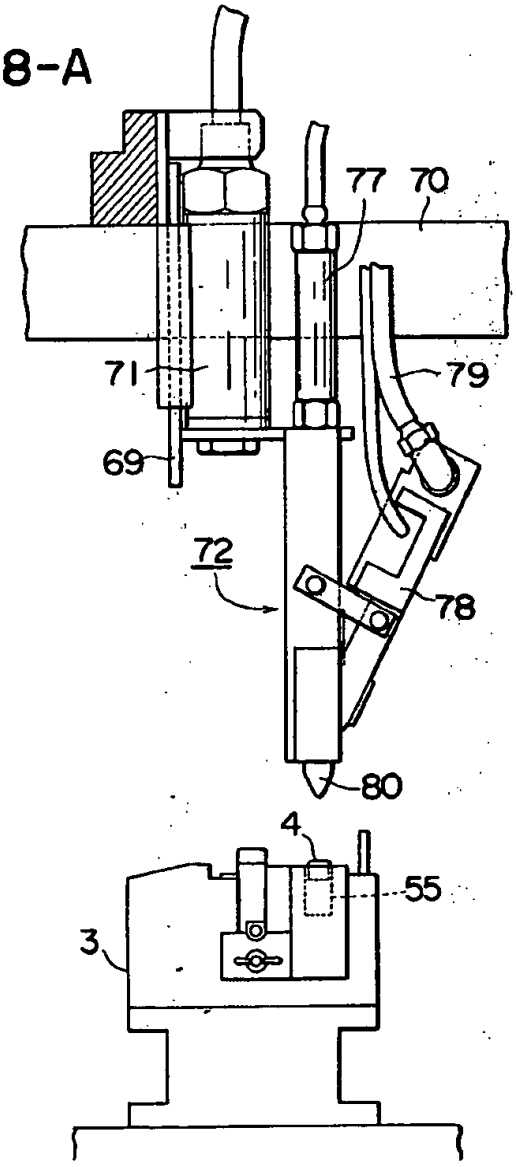


FIG. 18-B

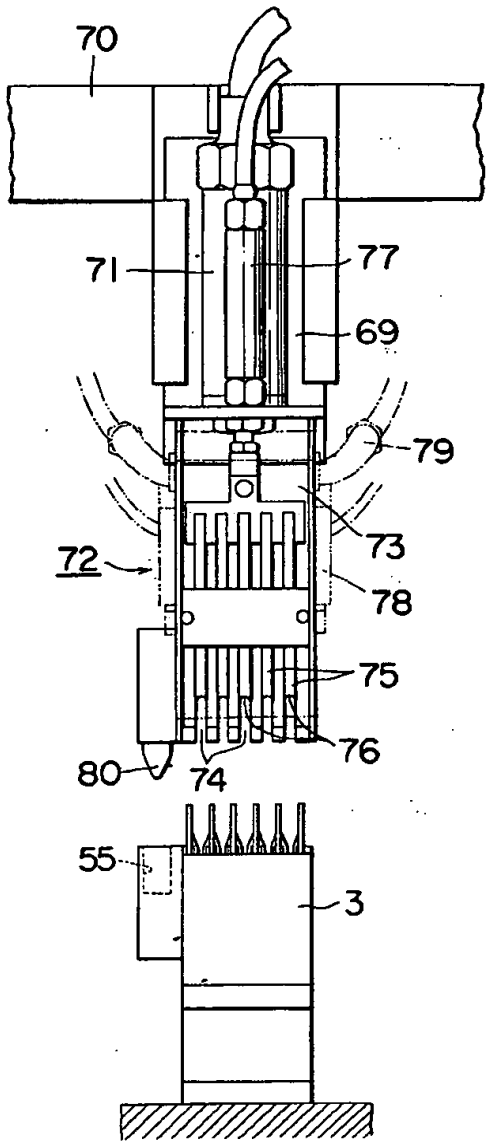


FIG. 19-A

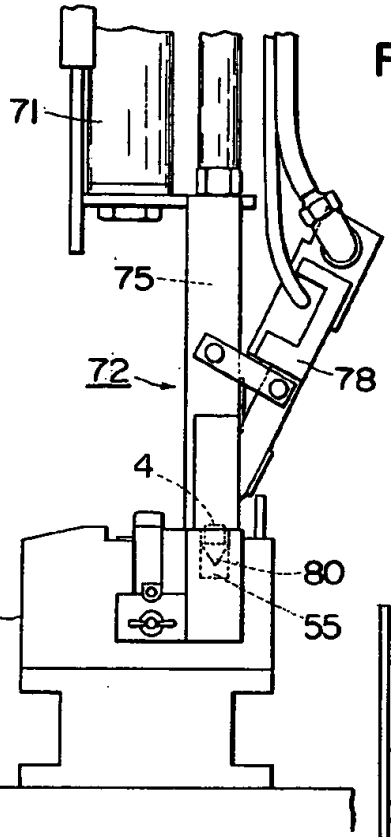


FIG. 19-B

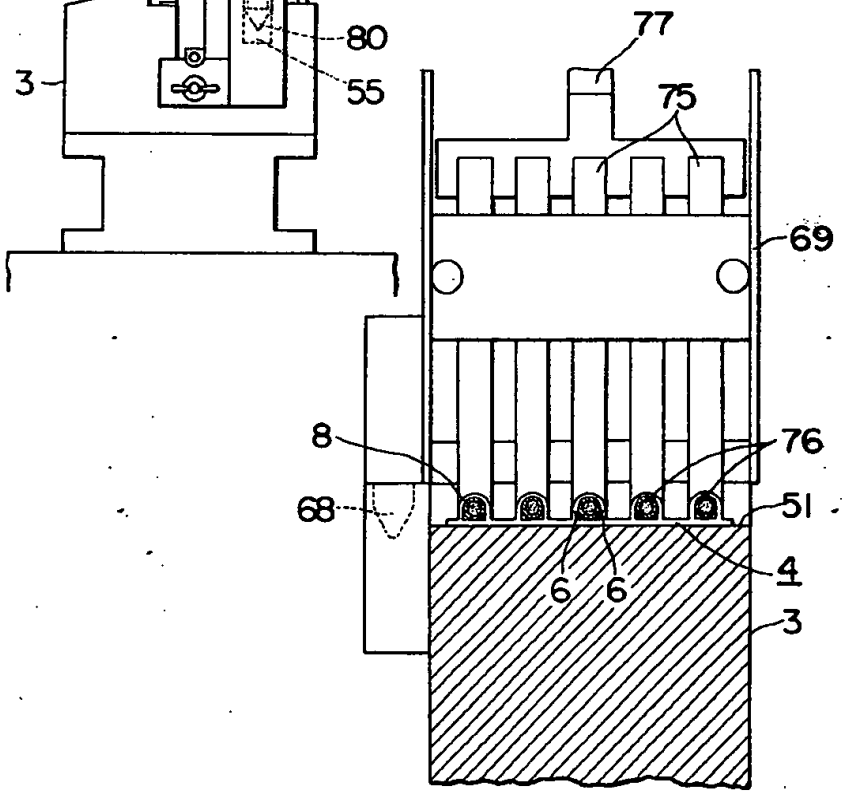
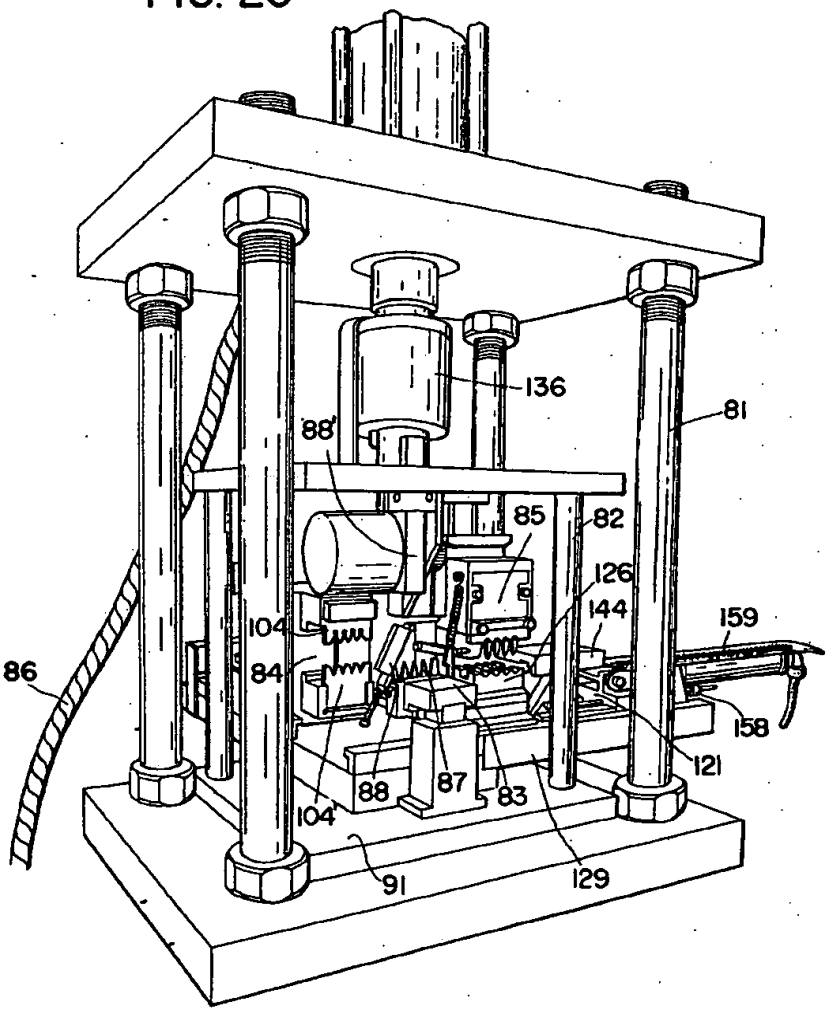


FIG. 20



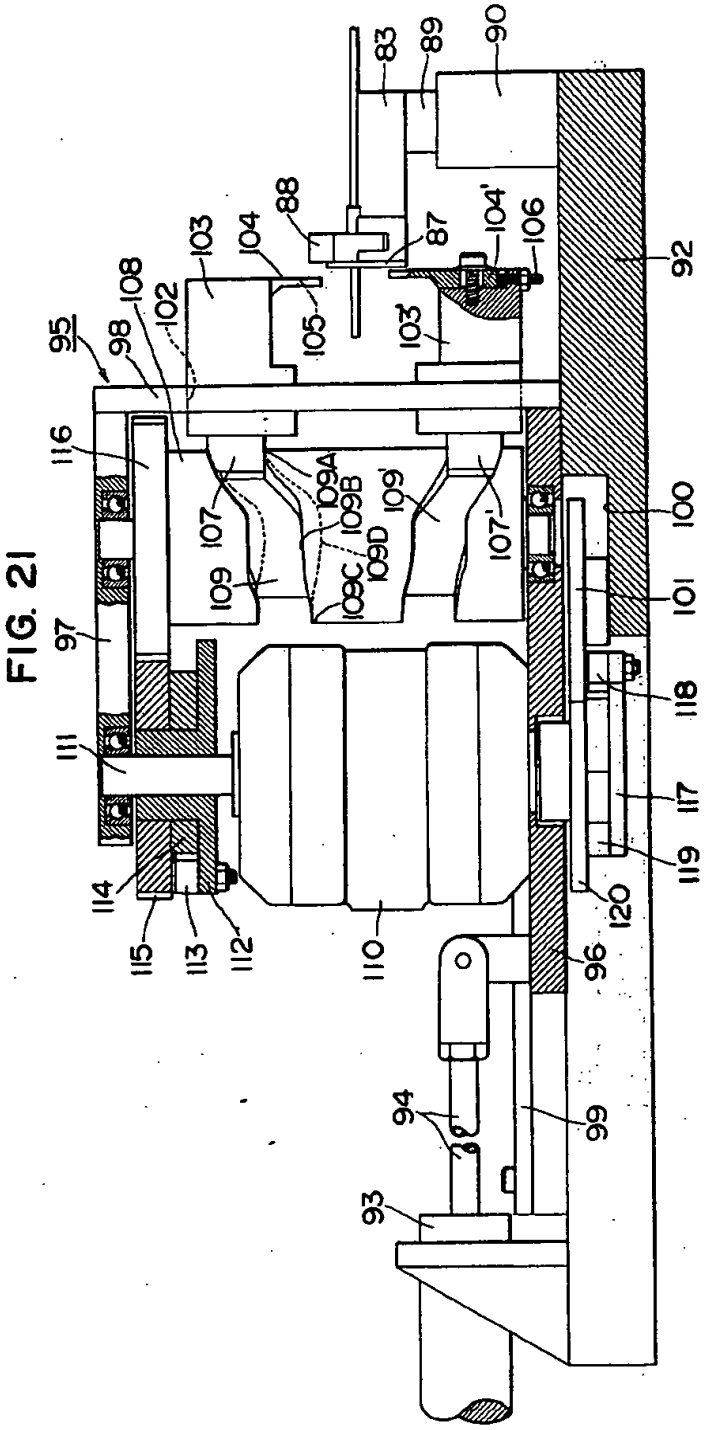

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FIG. 21

FIG. 22

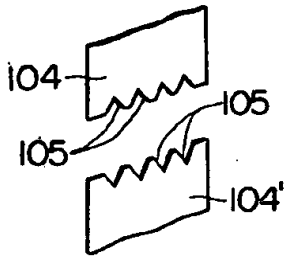


FIG. 23

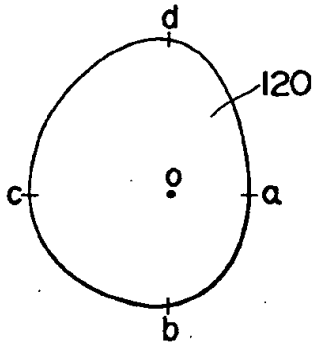


FIG. 24-A

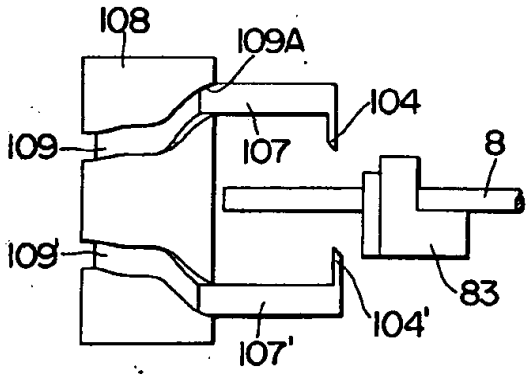


FIG. 24-B

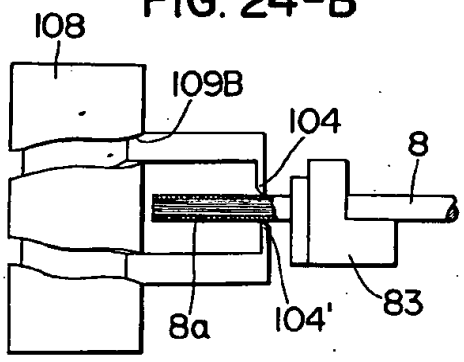


FIG. 24-C

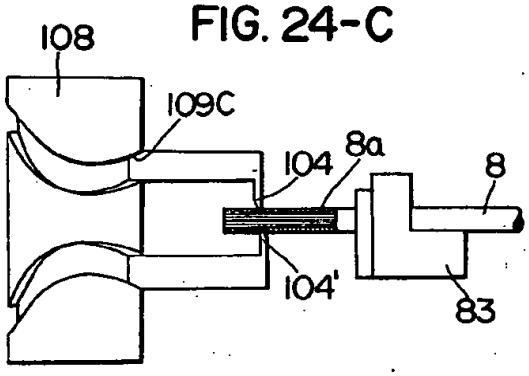
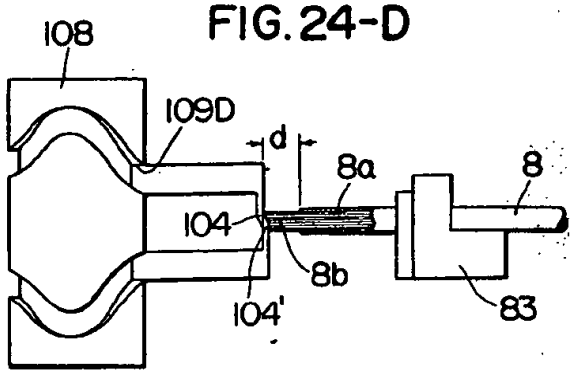


FIG. 24-D



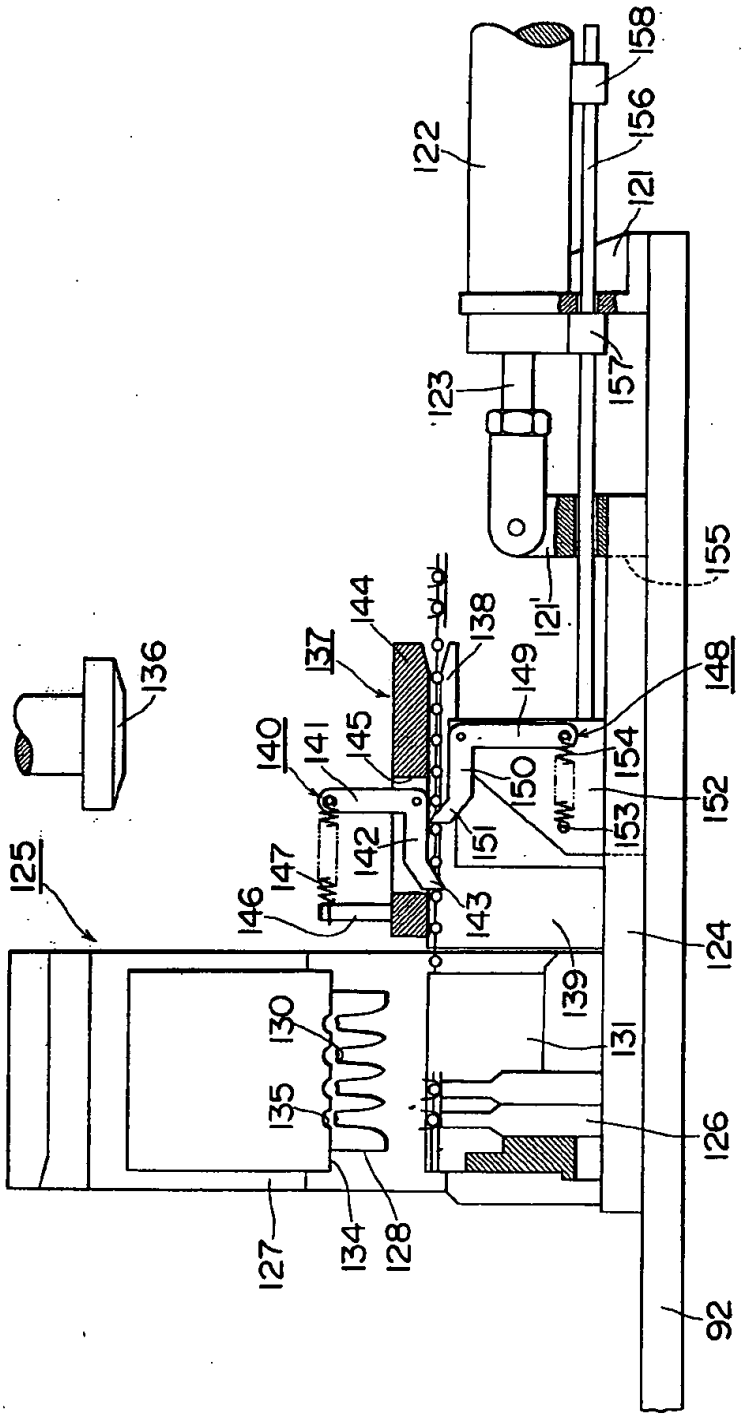

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FIG. 25

FIG. 26

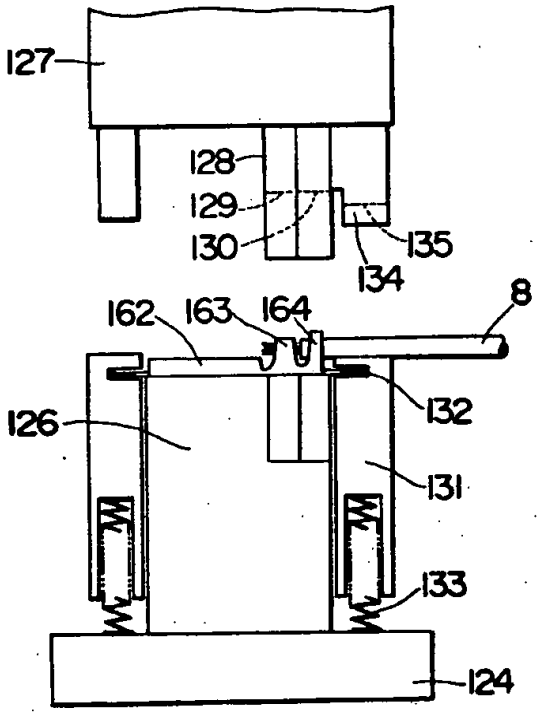
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FIG. 27

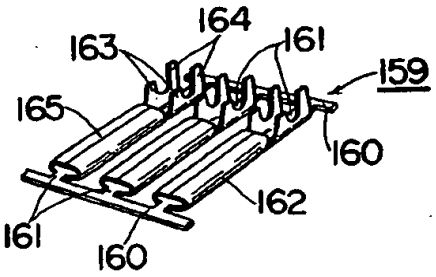
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FIG. 28-A

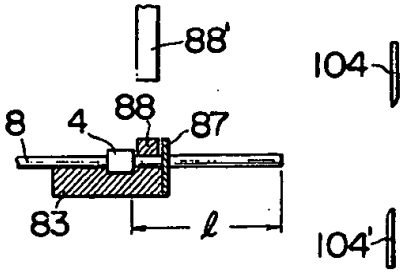


FIG. 28-B

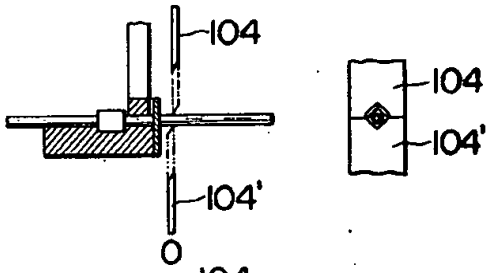


FIG. 28-C

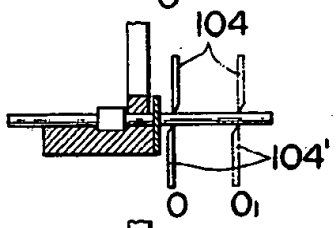


FIG. 28-D

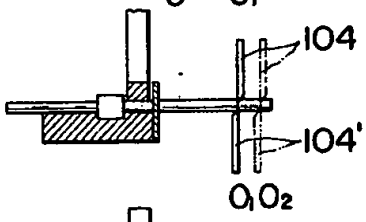


FIG. 28-E

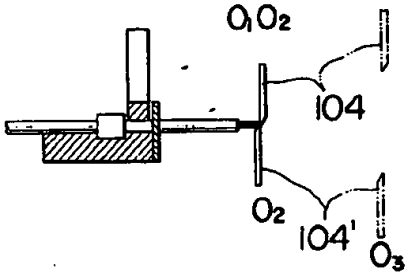


FIG. 29-A

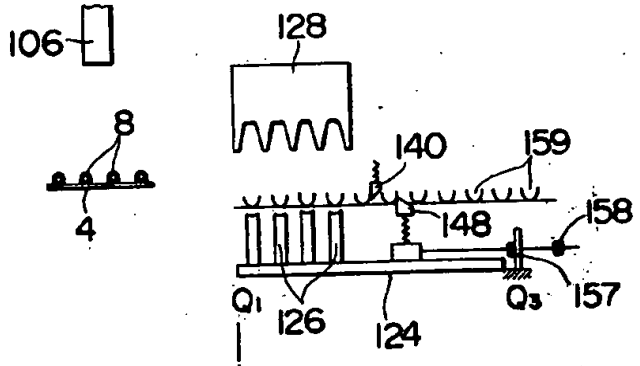
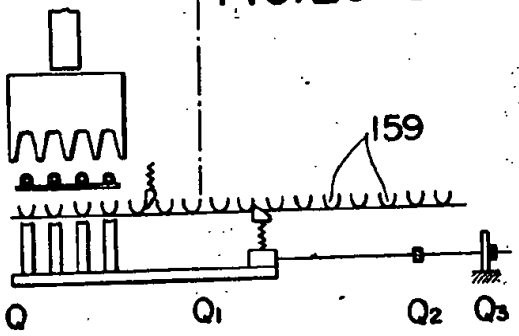


FIG. 29-B



WIRE-LAYING HEAD

This is a division of application Ser. No. 223,233, filed Jan. 8, 1981, patented Dec. 14, 1982 (U.S. Pat. No. 4,363,165) which is a division of Ser. No. 80,682; filed Oct. 1, 1979 still pending.

BACKGROUND OF THE INVENTION

The present invention relates to wire harnesses.

A wire harness generally consists of a large number of wires combined together to form branches of main lines. Terminals connectors or like members are connected to the respective branches. Various automatic wiring methods have heretofore been proposed to save time and labor in the production of such wire harnesses.

In principle, the prior art uses wires precut to a predetermined length and laid between intended terminals, connectors, or like members. Such processes are time consuming which is reflected by poor productivity.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a wire harness which can be manufactured by a time and labor saving method which comprises laying a wire on a plurality of pre-arranged bridges, cutting said laid wire to a predetermined length, and repeating the above step. The thus provided wire harness comprises a plurality of bridges arranged with predetermined spacings therebetween; and a plurality of covered wires held by said bridges at their end portions, said wires crossing over each bridge with suitable spacings therebetween, said end portions which extend from said bridge being of equal length to each other. In another aspect, the wire harness comprises a plurality of bridges arranged with predetermined spacings therebetween; a plurality of covered wires held by said bridges at their end portions, said wires crossing over each bridge with equal spacings therebetween, said end portions which extend from said bridge being of equal length to each other; and a terminal members attached to uncovered portion of each end portions. In a further aspect, the wire harness comprises a plurality of bridges arranged with predetermined spacings therebetween; a plurality of covered wires held by said bridges at their end portion, said wires crossing over each bridge with equal spacings therebetween, said end portions which extend from said bridge being of equal length to each other; a terminal member attached to an uncovered portion of each end portions; and a housing connector accomodating said terminal member.

Another object of the present invention is to provide a method which reduces the time and labor needed for the production of wire harnesses and thereby to make inexpensive wire harnesses. In order to achieve this objective, the method of the invention perform simultaneous laying and cutting of wires and, during the laying and cutting operation, secures neatly arranged end portions or wires to a bridge at suitable spacings so as to facilitate the subsequent easy connection of metallic terminal members and the fixation of connectors.

More specifically, the method according to the invention uses a plurality of wiring blocks arranged at given distances on a work table prior to wiring procedures. Layed on each block is a bridge for carrying thereon a set of suitably spaced wires. With a wiring head having nosepieces in the form of coil springs at its leading end, the process comprises the steps of anchoring a piece of wire to a first wiring block, stretching the wire toward a second wiring block, anchoring the wire to said second block and cutting the wire. The procedure is repeated to lay a plurality of wires successively between those desired wiring blocks. The bridge retains end portions of the corresponding set of wires in suitably spaced positions.

The thus obtained set of wires are further subjected to a terminal fixing step and a connector housing attaching step.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1-A illustrates a wire harness prepared on a worktable at a stage of the method of the present invention;

FIG. 1-B is a perspective view of one embodiment of the invention having a bridge engaging a wire thereon which is being subjected to a step of the method of FIG. 1-A;

FIG. 1-C is another example of a bridge;

FIG. 1-D is a further example of a bridge;

FIG. 2 shows a wire harness prepared at a stage subsequent to that shown in FIG. 1-A;

FIG. 3 shows a wire harness prepared at a stage subsequent to that shown in FIG. 2;

FIG. 4 shows a wire harness prepared at a final stage subsequent to that in FIG. 3;

FIG. 5 is a perspective view of a device for preparing a wire harness according to the present invention;

FIG. 6 is an enlarged side elevational view, cross-sectioned in part, of a wiring head used in the device of FIG. 5;

FIG. 7 is a plan view of the wiring head of FIG. 6;

FIG. 8 is an enlarged side elevational view, partly in section, of a wiring jig provided in the wiring head of FIGS. 6 and 7;

FIG. 9 is an enlarged side elevational view, partly in section, of a mechanism for the vertical reciprocation and rotation of a clamping jig attached to the wiring head of FIG. 6;

FIG. 10 is an enlarged side elevational view of the clamping jig of FIG. 9;

FIG. 11 is a perspective view of one of wiring blocks arranged on the worktable shown in FIG. 1-A;

FIGS. 12-A, 12-B, 12-C show positional relationship between the wiring block, the wiring jig, and the clamping jig;

FIGS. 13-A to 13-E show a series of wiring steps by using the wiring blocks, the wiring jig, and the clamping jig;

FIGS. 14-A and 14-B show a situation where two wires are to be laid on one another and subjected to the cutting step;

FIG. 15-A is a plan view of another embodiment of a wiring block to cope with the situation shown in FIGS. 14-A and 14-B;

FIG. 15-B is a side elevational view of the wiring block of FIG. 15-A;

FIG. 15-C is a front elevational view of the wiring block of FIG. 15-A;

FIG. 15-D is a cross sectional view of the wiring block of FIG. 15-B taken along the line d-d thereof;

FIGS. 16-A to 16-E show in sequence the operation of an arm provided on the wiring block of FIGS. 15-A to 15-D;

FIG. 17 shows another example of a wire harness obtained by the wiring block of FIGS. 15-A to 15-D;

FIG. 18-A shows in a elevational a fusing unit under which the work table is adapted to travel;

FIG. 18-B is a front elevational view of the fusing unit of FIG. 18-A;

FIG. 19-A illustrates an engagement of the fusing unit and of the wiring block;

FIG. 19-B is a front elevational view of FIG. 19-A;

FIG. 20 is a perspective view of a device for removing an insulation covering of one end portion of each wire of the wire harness and fixing a terminal thereon;

FIG. 21 is a side elevational view, partly in section, of wire uncovering and cutting unit provided in the device of FIG. 20;

FIG. 22 is a fragmentary view illustrating the cutting edges attached to the unit of FIG. 21;

FIG. 23 is an illustration of a flat cam attached to the unit of FIG. 21;

FIGS. 24-A to 24-D shown in sequence an operation of the cutting edges to remove an insulative covering of the wire and cutting the wire conductor;

FIG. 25 is a front elevational view of a terminal fixing unit provided in the device of FIG. 20;

FIG. 26 is a side view of an illustration of a wire harness and a train of interconnected terminal members which are supplied into said unit;

FIG. 27 is a perspective view of the train of terminal members supplied as shown in FIG. 26;

FIGS. 28-A to 28-E are a series of views or illustrations of the operation of the wire uncovering and cutting unit; and

FIGS. 29-A to 29-B are schematic views illustrating the operation of the terminal fixing unit.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will hereinafter be described in detail with reference to the accompanying drawings.

Referring to FIG. 1A, the reference numeral 1 designates a work table on which pins 2 and wiring blocks 3 are positioned.

Lying on each of the wiring blocks 3 is a bridge 4 which, as viewed in FIG. 1B, comprises a base 5 and multiple pairs of parallel fusable holding pieces 6 spaced at common perpendicular intervals and extending along the longitudinal direction of the base. The holding pieces 6 in each pair have bevelled sides or slants 7 on their outer top surfaces. In use, the bridge 4 is suitably made for the intended number of wires to be nested in the bridge. Preferably, the bridges 4 are formed of a thermoplastic resinous material similar to that employed for insulative coverings of wires. However, the bridge may be made of any material if the wire 8 is pasted or adhered between the holding pieces 6' by suitable means, such as an adhesive K as shown in FIG. 1-C. Alternatively, the bridge may have a plurality of resilient holding pieces 6" such that wires 8 are resiliently held therebetween when pressed in.

Wires 8 are securely nested in sequence in between the cooperating pairs of pieces 6 on each bridge 4 by a cooperative mechanism including the blocks 3 and a programmable automatic machine, i.e. a wiring head with a clamping jig. Those portions of respective wires 8 extending beyond the bridge 4 are cut off at a predetermined length l from the bridge. The wires are laid over corresponding blocks 3 thereby constituting a wire harness generally designated A in FIG. 1-A.

After the installation of the wires 8, table 1 is bodily moved to the next station in which a fusing unit corresponding to each block 3 is activated to melt the pieces 6 of the bridge 4 simultaneously onto the insulative coverings of the wires 8. Strips of tape 9 for temporary fastening are then wound around branching portions of the respective sets of wires.

The procedure stated above yields a wire harness B shown in FIG. 2. In harness B, wires 8 extend at predetermined spacings and in predetermined numbers and the bridges 4 securely hold the corresponding sets of wires at a given spacing.

The wires of the wire harness B are layed automatically at the required spacings and numbers while their terminal portions are neatly arranged and fixed by the bridges with a predetermined length thereof extending beyond the bridges. This type of wire harness B through only semiprocessed can be stored and transported advantageously before it advances to any subsequent step.

In a wire harness C illustrated in FIG. 3, each of the wires 8 rigid on the bridge 4 has its insulative covering removed at the end portion by an insulative covering removing unit, and, a terminal member 10 is affixed to the bare wire end by a terminal fixing unit.

Each bridge 4 in wire harness C retains the end portions of each set of wires 8 permitting a plurality of terminal members 10 to be attached simultaneously to the individual wires. Furthermore, as seen in FIG. 4, all the terminal members can be connected to a connector housing 11 simultaneously and easily.

A wire harness D in its fully processed state shown in FIG. 4 has wires 8 whose aligned end portions are securely held in the bridge 4 by fusion. Thus, when a tensile force is applied locally to specifically one of the wires, such as wires 8' as during transportation, storage or actual installation in an automobile, the bridge 4 disperses the tension to prevent the associated terminal member 10 from disengaging with the connector 11. However, if no tensile force is expected to be applied to a wire of the wire harness D in any subsequent step, then the bridge 4 may be detachably provided on the wire harness.

Referring to FIGS. 5 to 19-B, a process according to the invention will be described.

In FIG. 5, a wiring apparatus is shown in a general perspective view. The apparatus includes a pair of threaded X shafts 12 extending along opposite longitudinal edges of the work table 1. Cross-beam 13 is movable on and along X shafts 12 and carries thereon threaded Y shaft 14 on which a wiring head 15 is movably supported. X shafts 12 are driven for rotation by a first motor (not shown) whereas Y shaft 14 is driven by a second motor (not shown). By suitably setting the amounts of rotation of shafts 12 and 14, the wiring head 15 and the wires 8 held by the head 15 can be brought to any desired position among the respective blocks 3 arranged on the work table 1. A control unit 16 is adapted to store an entire process for wiring programmed on a magnetic tape (NC control). Reference numeral 17 is a reel station where wires 8 whose insulative coverings have different colors are stored on a plurality of independent reels. Wires 8 are payed out to the wiring head 15 through corresponding capstans 18 which serve to reduce the magnitude of tension imparted to the wires being driven by a motor (not shown) in the intended direction of wire feed.

As depicted in side elevation in FIG. 6, the wiring head 15 includes frame 19, a plurality of wiring jigs 24 located on top of frame 19 and a clamping jig 45 posi-

tioned below the frame 19. The jigs 24 and 45 are each reciprocated and rotated relative to a predetermined position.

An annular member in the form of a jig mount 21 for mounting the wiring jigs 24 is mounted to frame 19 rotatably through a plurality of guide rollers 20. The jig mount 21 is operatively connected to a limited speed motor 22 to rotate in a horizontal plane.

Wiring jigs 24 are passed through respective tubular guides 23 which are spaced equidistant along the circumference of jig mount 21. Each of the wiring jigs 24 is locked at a preselected level by a knock pin 25.

Differently colored wires 8 are payed out from the reel station 17 to individual wiring jigs 24. Jig mount 21 when driven by motor 22 will bring a selected wiring jig 24 to a predetermined position P in FIG. 7.

Each jig 24 reaching the position P is reciprocated vertically in accordance with the action of a raising and lowering unit 26. Denoted by the reference numeral 27 is a motor adapted to drive capstan 33 provided to the jig 24.

FIG. 8 illustrates a detailed construction of each wiring jig 24. As shown, wiring jig 24 comprises tubular member 29 having through bore 28 extending axially therethrough to accommodate a wire. Tube 29 carries on its outer periphery a bar 30 which is engagable with the raising and lowering unit 26 (FIG. 7). Capstan head 31 and recoil prevention assembly 35 are mounted above the tube 29. Mounted below the tube 29 is a nozzle or nosepiece 38.

Capstan head 31 has a gear wheel 32 which is driven by motor 27 shown in FIG. 7 and capstan 33 is faced by a slack preventing piece 34. The recoil preventing assembly 35 has a pair of pawls 36 constantly biased by spring 36*a*. Flexible wire guide 37 is provided at the top of the recoil preventing assembly 35. The nosepiece 38 is in the form of a coil spring with resiliency such that a given intensity of tension resulting from a travel of jig 24 causes a flexure of the nosepiece in a direction opposite to the direction of travel and, upon the release of the tension, the nosepiece recovers its position. Preferably, the nosepiece 38 is additionally capable of straightening the wire 8 if it is bent.

Wire support 38*c* is nested in the tube 29 and carries a nosepiece support tube 38*a* fastened to its lower end by means of a screw 38*b*.

With this arrangement of the wiring jig 24, wire 8 enters jig 24 through top wire guide 37, passes between pawls 36, and is passed one turn round capstan 33. From capstan 33, the wire extends downwardly through tubes 38*c* and 38*a* and extends from lower end of nosepiece 38.

An end portion of wire 8 protruding from the nosepiece 38 is retained by clamping pawls 52 (see FIG. 11) mounted on block 3 in a manner described hereinafter. In this situation when motor 27 is energized so as to drive the wiring jig 24 causing it to run and impart a tension to wire 8, the tension is controlled by the rotating capstan 33 promoting smooth feed of the wire.

In the event wire 8 is cut by cutting edge 48 of clamping jig 45 (see FIGS. 9 and 10) which will be discussed later, the tension in wire 8 is released abruptly. In this instance, a slack preventing piece 34 facing capstan 33 exerts a resilient pressure force to prevent the recoil of the wire. Consequently, a constant measure of wire 8 extends from the outlet of the nosepiece.

Additionally, wiring jig 24 has in its upper portion the pair of pawl's 36 which are constantly biased by the spring 36*a*. Pawls 36 prevent wire 8 from falling out of the jig 24 even when the jig is stationary. Thus, jig 24 positively holds the wire irrespective of the operating condition.

A mechanism for two different kinds of the movements of clamping jig 45 is indicated in side elevation in FIG. 9. Body 39 of the clamping jig is mounted to frame 19 of the wiring head so as to reciprocate vertically relative to the frame by the action of actuator 40 associated therewith. Annular jig mount 41 functions as a pulley and is rotatably mounted to the jig body 39 and is in a position where its center coincides with the axis of a wiring jig 24 at the position P. The angular orientation of jig 45 is controlled by a limited speed motor 42 which is provided with a timing pulley 43. Passed over this timing pulley 43 and the pulley 41 is an endless belt 44. With this construction, motor 42 drives the clamping jig 45 to a desired position about the wiring jig 24 while the actuator moves the clamping jig up or down as desired.

As shown in FIG. 10, clamping jig 45 has a front end clamping plate 46, guide plate 47 with coil spring 47*a*, cutting edge 48 and a rear end clamping plate 49 arranged in succession radially from the inner end to the outer end. Guide plate 47 and the cutting edge 48 protrude slightly beyond the lower ends of clamping plates 46 and 49 and are positioned in perpendicular relation to the clamping plates. Clamping plates 46 and 49 are located symmetrically to each other with respect to the cutting edge 48.

Referring to FIG. 11, wiring block 3 has a plurality of guide pins 50 at its front upper end and guide slots 54 at the rear end. Interposed between the guide pins 50 and guide slots 54 are recesses 51 for receiving a bridge 4, a series of clamping pawls 52 and a block 53 against the top surface of which cutting edge 48 will abut. Said block 53 is rigidly mounted on block 3 and functions as an edge bearer. Block 3 is also provided with a bore 55 in the vicinity of one lateral end of recess 51; bore 55 is adapted to receive a fusing jig which will be referred to hereinafter. Reference numeral 56 designates a screw for releasing the clamping pawls 52.

Guide pins 50, and guide slots 54 serve to guide the nosepieces 38 of respective wiring jigs 24 and are provided in accordance with the intended number of wires. Clamping pawls 52 retain wires during the wiring operation and until a subsequent fusing step is over.

Positional relationships of blocks 3-1 and 3-2, wiring jig 24 and clamping jig 45 are indicated in FIGS. 12A-12C. A bridge 4 is nested in the recess 51 of block 3 prior to a start of the wiring operation. At a starting point of wiring (FIG. 12-A), nosepiece 38 of wiring jig 24 is resiliently deformed into engagement with the bridge 4 and in between guide pins 50. A predetermined length of the end portion of wire 8 extends beyond the bridge 4 and is positioned between neighboring clamping pawls 52.

As clamping jig 45 is then moved downwards as viewed in FIG. 12-B, the free end of wire 8 is engaged by the guide plate 47 which is projected beyond the bottom of the clamping plate 46. The guide plate therefore centers the wire 8 between the clamping pawls 52 and then the front end clamping plate 46 positively presses the wire 8 until pawls 52 grip the wire therebetween. The wire at this instant is also retained between the corresponding pair of confronting pieces 6 on the bridge 4.

In this way, guide plate 47 and clamping plate 46 in cooperation allow the part of the wire projecting from nosepiece 38 to be retained positively on the block 3 despite the slight wire flexure which has occurred in the initial stage of wiring.

FIG. 12-C shows wiring block 3-2 which is located in opposite relation to first-mentioned block 3-1 to define a terminal point of the wiring path. At this point of the wiring process, wire 8 payed out of nosepiece 38 has been layed under tension from the block 3-1 to the block 3-2 through pins 2 on the table 1 and guide pins 50 on the blocks) (FIG. 13-A to FIG. 13-E). The nosepiece is flexed into engagement with a guide slot 54 of the block 3-2 as illustrated. Under this condition, the wire 8 is aligned with a central region between neighboring clamping pawls 52 and that between pieces 6 on the bridge 4.

When clamping jig 45 is lowered in the above situation, its rear end clamping plate 49 urges the wire 8 into the gap between clamping pawls 52 while at the same time associated cutting edge 48 in cooperation with the surface of the block 53 cuts the wire to a predetermined length.

Thereupon, motor 42 (see FIG. 9) is energized to turn the clamping jig 45 to a position immediately to the rear of wiring jig 24. This restores conditions to an initial stage of the wiring process.

Wiring procedures using wiring jig 24, clamping jig 45 and block 3 will now be described with reference to the FIGS. 13A–13E.

(1) A selected wiring jig 24 is brought to a predetermined position P whereupon the unit 26 is driven to lower jig 24 to a position rearwardly of block 3-1. (FIG. 13-A)

(2) Wiring jig 24 is moved along X shafts 12 and Y shaft 14 until it reaches the condition for starting a wiring operation (see FIG. 12-A). Then, the clamping jig 45 is lowered by the actions of actuator 40, thereby fixing a predetermined length of wire 8 on the block 3-1 (see FIGS. 12-A and 12-B) and then jig 45 is raised and capstans 18 and 33 are driven. (FIG. 13-C)

(3) Wiring jig 24 is caused to travel toward wiring block 3-2 while laying out wire 8. (FIG. 13-C)

(4) Wiring jig 24 is positioned at the terminal point of wiring (see FIG. 12-C) relative to block 3-2 whereupon. the clamping jig 45 is again lowered to lock and cut the wire 8 and is then raised. Subsequently, the drive of capstans 18 and 33 is interrupted. (FIG. 13-D)

(5) The orientation of the clamping jig is as follows. Wiring jig 24 moving along the X and Y shafts is shifted to a position behind block 3-2 while the clamping jig 45 is brought to a position immediately to the rear of the wiring jig 24. (FIG. 13-E)

(6) Moving along shafts X and Y toward another preselected wiring block, wiring jig 24 is elevated by the action of unit 26 and is returned to the start position.

(7) By repeating steps (1) to (6) with one or more of jigs 24 a desired wire harness A as presented in FIG. 1-A is now obtained.

Referring to FIG. 14-A (FIGS. 15C and 15D), wire 8 held between clamping pawls 52 is supported by block 53 for the cutting operation. If end portions of wires are required to be held in the bundle, another wire is laid upon the already cut wire as shown in FIG. 14-B, preventing proper cutting of wire 8. FIGS. 15-A to 16-E show a modification of wiring block 3 in which the above situation is avoided.

Wire retaining groove 57 (FIGS. 15C and 15D) is defined between lower portions of neighboring clamping pawls 52 while edge bearing member 59 faces recess 58 lying between the pawls 52 and guide groove 54' and is capable of elevating and tilting movements.

Edge bearer member 59 includes a pair of arms 60 each of which has a lower portion journalled to the body 3 by cam shaft 62 received in a vertically elongated slot 61 of the arm; slot 61 has its upper end enlarged. Spring 63 is anchored at one end to an intermediate portion of each arm 60 and at the other end to the upper part of body 3. Arms 60 are usually biased by springs 63 to hold a position inclined toward guide grooves 54' on top of body 3.

Wire guide groove 64 extends on that surface of the edge bearer member 59 which faces the clamping pawls 52. Lugs or cams 65 project upwardly from the edge bearer on opposite sides of groove 64. These lugs 65 are adapted to pull arms 60 up from the inclined position when engaged by the cutting edge 48. The wiring block further includes pins 66 and 67 for retaining spring 63 and stop pins 68 adapted to limit the tilting movement of the arms 60.

Operation of the wiring block 3 having the above construction will be described hereinafter.

(1) As shown in FIG. 16-A, wire 8 is laid on the clamping pawls 52 on wiring block 3 and edge bearer 59. In this situation, each arm 60 is kept by the tension of the spring 63 in a position raised obliquely upwardly about the lower end O_1 of its elongate slot 61.

Laying of the wire is performed by wiring jig 24 as already discussed in conjunction with FIGS. 12A–12C.

(2) Under the above-mentioned condition, the cutting edge 48 of clamping jig 45 is lowered into engagement with slants 65*a* of lugs 65. The resultant horizontal component of a force action on slants 65*a* causes arms 60 to pivot to a raised position about point O_1 of the corresponding slots 61.

Thus, the tension and angular position of each spring 63 is preselected such that the following relations are satisfied:

$$F_h > T_h,\ F_v > T_v$$

Where F_h and F_v denote horizontal and vertical components of a force action on the slant 65*a*, respectively, and T_h and T_v horizontal and vertical components attributable to the resiliency of the spring 63. This permits arms 60 to be raised about point O_1 of the slots 61. (FIG. 16-B)

(3) Another lowering of cutting edge 48 moves arms 60 downwardly along slots 61 until wire 8 is cut off. The center of pivotal movement of arm 60 is shifted by spring 63 from O_1 to point O_2 contained in an upper portion of slot 61. (FIG. 16-C)

(4) When cutting edge 48 starts its upward or return stroke, arm 60 is retained in the upright lowered position through the upper enlarged portion of slot 61. Upon the disengagement of cutting edge 48 from slant 65*a*, the arm tilts backwardly about point O_2 under the action of the spring 63. At this instant, cam shaft 62 leaves enlarged portion O_2 so that arm 60 is elevated obliquely along slot 61. (FIG. 16-D)

(5) Raised by spring 63 while inclining, arm 60 returns to the initial position (FIG. 15-A) without pushing the cut wire 8 up. Moreover, cut wire 8 does not give any touch to the edge bearer 60 owing to the guide groove 64 (FIG. 15D). (FIG. 16-E) Edge bearer 60 is

thus always positioned above a wire which has been cut off as shown in FIGS. 16-A and 16-B. Accordingly, when overlayed on the cut wire, the next wire will be cut off by cutting edge 48 while being pushed down (FIG. 16-B). A plurality of wires can be retained in superposed relation with the aid of the recess or wire guide grooves 64 defined between lower portions of the clamp pawls 52.

The wiring block of this type is usuable in combination with ones as shown in FIG. 11 to prepare a wire harness which, as depicted in FIG. 17, has a desired configuration such as block 3*a* in which end portions of wires 8 are held at equal spacings on bridge 4 and block 3*b* in which a plurality of wires are retained in superposed relation.

A positional relationship between wiring block 3 and a fusing unit is illustrated in FIGS. 18-A and 18-B. A fusing jig 72 includes body 69 which is vertically mounted to frame 70 to reciprocate through actuator 71.

The body 69 of the fusing jig is provided therein with a slidable plate 73 having a plurality of slots 74. Accommodated in the respective slots 74 are pressing bars 75 which are arranged in a comb-like configuration and each having an arcuate recess 76 at the lower end. These pressing bars 75 are reciprocated vertically following the action of actuator 77. Device 78 for supplying hot air is tiltably supported by body 69 of the jig.

Accommodating a heater (not shown), the blasting device 78 feeds air from ducts 79 and blasts hot air onto pieces 6 on bridge 4, thus fusing the insulative coverings of wires 8 therewith. The fusing jig is also provided with pin 80 which is engagable in the previously mentioned bore 55 of block 3.

To fuse bridge 4 and the wires 8 together, the fusing jig 72 will be explained as depicted in FIG. 19-A. In FIG. 19-A, actuator 71 lowers pin 80 of jig 72 into engagement in the bore 55 of the wiring block 3 and positions the respective pressing bars 75 on bridge 4. The blasting device 78 then blow hot air toward bridge 4.

After hot air processing actuator 77 is driven to lower pressing bars 75 into recess 51 of block 3 where bridge 4 is positioned, the tops of the pieces 6 are pressed against and fused to the insulative coatings of the corresponding wires 8 by the arcuate recesses 76 of bars 75 as viewed in FIG. 19-B. It will be recalled here that the confronting pieces 6 on bridge 4 have slants 7 (FIG. 1B) along the upper edges thereof.

Pieces 6 are engaged and deformed inwardly towards each other to seal wire 8 therein by the recessed bottom of the corresponding pressure bar 75. The fusing jig 72 may be provided corresponding to each of multiple blocks 3 shown in FIG. 1-A in order to perform all at one time. Branching portions of respective wires 8 are thereafter wound with strips of tape 9, yielding a wire harness B as indicated in FIG. 2.

The thus obtained wire harness B is further subjected to a insulative covering removing step, a terminal fixing step, and a connector housing attaching step.

Referring to FIG. 20, an apparatus embodying the present invention includes outer framework supporter 81 and inner framework supporter 82. Within inner framework supporter 82, there is provided wire holder 83, uncovering and cutting unit 84 and terminal attaching unit 85. These assemblies 84 and 85 function in cooperative relation with wire holder 83. Denoted by the reference numeral 86 is an electric wiring extending from a control box (not shown) to the respective units of the apparatus.

Detailed constructions and operations of the various units will be stated in succession.

Wire holder 83 serves as a platform on which end portions of wire harness B are held. A plurality of guide pins 87 project upwardly from the rear end of the platform while an auxiliary clamp 88 is pivoted to the platform in such a manner as to be movable toward and away from the series of guide pins 87. Wire holder 83 has leg 90 of a rectangular section supported through a spring and a knock pin (not shown) by frame 90 which uprises from seat 91 of inner framework supporter 82. Under usual condition, the wire holder is urged upwardly by the spring and held at a predetermined level by the knock pin. In the event of attaching terminal members to wires, the knock pin is retracted by a movement of terminal fixing unit 85 to lower the wire holder whereby terminal members are allowed to reach a station below uncovered portions of the wires. Reference numeral 88' designates a clamp adapted to press auxiliary clamp 88 from above.

Unit 84 is illustrated in partly sectioned elevation in FIG. 21. Base plate 92 is positioned at the rear of the wire holder 83.

Mounted rigidly to a rear portion of base 92 is cylinder 93 having piston 94 which is connected to lower plate 96 forming part of frame 95. Guides 99 extend along opposite sides of base 92 to guide the movement of lower plate 96 as will be described hereinafter. Base 92 has in its front portion recess 100 in which disc 101 is rotatably journalled. Cam 120 is engagable with disc 101 to limit the movement of frame 95 toward wire holder 83 caused by cylinder 93.

Front plate 98 forming another part of frame 95 is formed with elongate slot 102 extending vertically in an intermediate area of the front plate 98. Upper edge holder 103 and lower edge holder 103' are vertically slideable and guide by slot 102.

Reference numerals 104 and 104' designate upper and lower cutting edges, respectively, each having a plurality of equally spaced and V-shaped edge portions 105 (four shown in the drawing) as viewed in FIG. 22. Edge members 104 and 104' are secured to the front ends of the corresponding holders 103 and 103' such that their edges portions 105 confront each other while having their backs aligned along a common axis. Meshing of lower cutting edge 104' with upper cutting edge 104 can be finely adjusted by adjusting screw 106.

Cylindrical cam 108 is journalled to upper and lower plates 97 and 96 of frame 95 at opposite ends and is provided with cam grooves 109 and 109' on its periphery. Arms 107 and 107' extending from the rear ends of the edge holders 103 and 103' are slidably engaged in the cam groove 109 and 109', respectively.

The cam grooves 109 and 109' extend throughout the circumference of cam 108 in vertically symmetrical relation. Each of the cam grooves has four substantially horizontal stepwise sections 109-A, 109-B, 109-C and 109-D at regular spacings of 90° along the circumference of cam 108. Accordingly, cam 108 in rotation causes the upper and lower cutting edges 104 and 104' to move toward and away from each other.

The horizontal sections 109-A to 109-D of the grooves 109 and 109' have such levels as will be discussed in conjunction with FIGS. 24-A to 24-D. When arms 107 and 107' associated with the corresponding edge holders move from the section 109-A to the sec-

tions 109-D via sections 109-B, 109-C, 109-D and back to 109-A in accordance with each counterclockwise 90° movement of cam 108, upper and lower cutting edges 104 and 104' are successively moved through:

(i) a position remotest from wires 8 (FIG. 24-A),

(ii) a position in which they touch insulative coverings 8*a* of the wires 8 from above and below (FIG. 24B),

(iii) a position in which they cut into the coverings 8*a* from above and below (FIG. 24-C),

(iv) a position in which they overlap each other to cut off conductors 8*b* of the wires (FIG. 24-D) and back to the position (i).

The rotation of cam 108 and corresponding movements of the cutting edges 104 and 104' are regulated by a reversible motor 110.

Capable of clockwise and counterclockwise movements of 90°, motor 110 is secured to lower plate 96 of frame 95 and has an output shaft 111 which rigidly supports and carries in its upper portion plate 112 having pawl 113. Gear 115 having ratchet teeth 114 on its underside is rotatably coupled over a cylindrical extension of the plate 112.

The gear 115 is constructed such that a clockwise movement of motor 110 causes gear 115 to turn in the same direction as ratchet 114 which is meshed with pawl 113. Upon a reverse rotation of the motor, however, pawl 113 releases ratchet 114 to permit idling of gear 115. The clockwise movement of motor 110 is transmitted to cam 108 through gear 115 and gear 116 which is rigidly mounted on a shaft of the cam 108 and is meshed with gear 115, thereby varying the position of the cutting edges 104 and 104'. A reverse rotation of the motor 110 however allows gear 115 only to idle without displacing the cutting edges.

Flat cam 120 held in sliding engagement with disc 100 functions to regulate the operating positions of the cutting edges 104 and 104'. As shown in FIG. 23, cam 120 has four curved points a, b, c and d at equal angular spacings of 90° around the circumference. The distances from the center o of the cam to the respective points a to d are selected to satisfy the following relation and equation:

$$oa<ob<oc<od$$

$$oc-ob=d$$

where d indicates the length of the uncovered conductor 8*b* of the wire 8.

In the situation depicted in FIG. 21, cam 120 is slidably engaged with disc 100 at its point a so that cutting edges 104 and 104' remain disengaged from each other at the position where they touch the wires 8. Subsequent reverse rotations of motor 110 cause cam 120 to turn reversely by 90° each whereby the cutting edge are moved from position O to position O_3 via position O_1 and position O_2 as shown in FIGS. 28-A to 28-E.

Terminal attaching unit 85 is illustrated in partly sectional front elevation in FIG. 25. Cylinder 122 is rigidly mounted through bracket 121 to one end (right end) of the base 92. Piston rod 123 extending from cylinder 122 is connected through bracket 121' to one end of frame 124 so that frame 124 is bodily movable laterally with respect to and behind wire holder 83.

Device 125 for pressing terminal members onto wires is mounted to frame 124 in a position opposite to the piston rod 123.

The pressing device as shown in FIG. 26 includes lower die 126 and upper die 128 secured to holder 127. Upper die 128 has on its underside grooves 129 and 130 which correspond to individual portions 163 and 164 of terminals 162 as will be discussed hereinafter. A shear blade 131 is mounted through springs 133 to the outer periphery of lower die 126. Shear blade 131 is formed with recess 132 for supporting terminals 162 in an upper portion of its inner wall. Shear blade presser 134 projects downwardly from die holder 127 and has grooves 135 on its underside for accommodating the escape of wires. Die holder 127 is constantly urged by springs (not shown) to a position above the lower die 126 and operated by a hydraulic ram 136.

Reference numeral 137 denotes a terminal conveyor unit made up of platform 138, first pawl 140 for preventing reverse travel of terminals and a second pawl 148 for feeding terminals.

Secured to frame 124 in the vicinity of the lower die 126 is a, platform 138 which comprises two generally L-shaped parallel side plates spaced suitably from each other. Each of these side plates is formed with a terminal supporting recess (not shown) in the same way as shear blade 131.

First pawl 140 is afforded by a generally L-shaped flat member having vertical arm 141 and horizontal arm 142 which has a downwardly inclined end portion 143.

Part of the pawl 140 where arms 141 and 142 join is pivotally mounted to a wall of window 145 formed through a central area of pawl mount 144. Spring 147 is anchored at one end to vertical arm 140 and at the other end to a pin 146 studded on the pawl mount 144, whereby horizontal arm 142 is constantly biased to urge terminals 162 downwardly with its lower surface.

Likewise, the second or feed pawl 148 takes the form of a generally L-shaped flat member having vertical arm 149 and horizontal arm 150. Horizontal arm 150 has an upwardly inclined end portion 151 which is contrastive to the downwardly inclined portion 143 of the first arm 140.

An intermediate bent portion of the pawl 148 is pivotally mounted to the upper part of a second pawl mount 152. This pawl 148 is biased by spring 154 retained by vertical arm 149 and pin 153 such that the upper surface of horizontal arm 150 constantly urges the terminals 162 upwardly.

The second pawl mount 152 has a base portion nested in a groove 155 extending along the center of frame 124 and is thus slidable along the groove while facing inner walls of the confronting side plates 139 of the terminal support 138. Feed rod 156 extends from the rear end of pawl mount 152 through the brackets 121' and 121. A pair of cooperating adjuster pieces 157 and 158 are held in threaded engagement on rod 156 on opposite sides of bracket 121 for the adjustment of the amount of terminal feed.

Turning to FIG. 27, and as generally designated by reference numeral 159, is a train of interconnected terminal members 162. The terminals 162 are united together in parallel relation at predetermined spacings by two parallel support pieces 160 and cross-piece 161. The assembly 159 also includes raised portions 163 and 164 for retaining conductors and insulative coverings of wires when processed, respectively, and electric contact portions 165.

Reference will now be made to FIGS. 28-A to 29-B for the description of a method of uncovering and cut-

ting end portions of wires and fixing terminal members to the same.

(1) Securely retained by bridge 4 except an end portion, each wire 8 is loaded on the wire holder 83 and nipped by guide pins 87 and auxiliary clamp 88. The cutting edges 104 and 104' remain in a position spaced backwardly from wire holder 83. (FIG. 28-A)

(2) The cutting edges 104 and 104' in their open position are moved toward wire holder 83 until the movement is interrupted at position O. (FIG. 28-B)

To effect this movement of the cutting edges, frame 95 is advanced by the action of cylinder 93 with arms 107 and 107' held in the sections 108-A of the grooves 109 and 109' as viewed in FIG. 24-A, causing the curved point a of flat cam 120 to abut against disc 101 and thus become halted.

(3) The cutting edges 104 and 104' are brought closer to each other to lightly nip wire 8 from above and below (position O) and then moved back to position O_1. (FIG. 28-C)

More specifically, motor 110 is first turned 90° clockwise so that cutting edges 104 and 104' nip the wire therebetween (FIG. 24-B) in accordance with the rotation (reverse) of cylindrical cam 108. Motor 110 is thereafter turned 90° reversely whereby the flat cam 120 is rotated (reverse) to move the cutting edges backwardly to position O_2. The drive pressure in this instance is preselected to be of such a magnitude as to permit a retreat of piston rod 123 of cylinder 122 during the rotation of first cam 120.

In the above procedures (2) and (3), cutting edges 104 and 104' hold wire 8 which has been neatly nested in between neighboring guide pins 87. Hence, the end portion of the wire is nipped positively even if bent in any direction and, moveover, the bent is corrected to straighten the wire.

In the position O_1 the cutting edges are respectively driven into the insulative covering 8*a* alone of the wire 8 and then moved back to position O_2. Consequently, wire 8 has its conductor 8*b* exposed over the length O_1–O_2 (FIG. 28-D).

More specifically, motor 110 is driven forwardly and reversely in sequence to cause reverse rotations of cylindrical cam 108 and flat cam 120. Frame 95 thus recedes while the cutting edges uncover wire 8 (FIG. 24-C).

At position O_2, the cutting edges cut the conductor 8*b* of the wire off and thereafter return to the initial position remote from the wire holder. As a result, the respective wires 8 are cut off at positions commonly distant from the bridge 4 to have their ends all aligned. Also, the exposed lengths d of the conductors 8*b* are the same as one another. (FIG. 28-E)

For the above procedure, motor 110 is again driven for successive forward and reverse rotations to turn cylindrical cam 108 and flat cam 120 reversely causing the cutting edges to obtain the cutting state (FIG. 24-D) and then position O_3. Subsequently, cylinder 93 is actuated to move frame 95 rearwardly whereupon motor 110 is again turned forwardly and reversely to thereby allow cams 108 and 120 and other members to restore the positions indicated in (1).

The peeling and cutting of wires are completed in the above-described manner. In short, motor 110 is driven for successive forward and reverse motions repeatedly four times to cause one full rotation of each of cams 108 and 120; the cooperative mechanism of the cams 108 and 120 actuate the cutting edges for nipping, peeling and cutting of wires in preselected positions.

(6) Terminal attaching unit 85 is located to the right of wire holder 83. (FIG. 20)

(7) Frame 124 is moved by the action of the cylinder 122 until fixing unit 125 reaches a position at the rear of wire holder 83.

Train 159 of terminals advance in correspondence with the number of wires 8 under the actions of L-shaped pawls 140 and 148. (FIG. 29-A)

(8) Individual terminals 162 in the train 159 are fixed onto the end portions of respective wires 8 while, at the same time, the connecting pieces 161 at opposite ends of terminal 162 are cut off and separated from the terminals.

More specifically, in FIGS. 29-A to 29-B, ram 106 is acutated to lower upper die 128 onto lower die 126 so as to press raised pieces 163 and 164 of terminals 162 firmly onto wires 8. Simultaneously, shear blade presser 134 is lowered to push shear blade 131 downwardly against the action of springs 133 thereby cutting the connecting pieces 161 off from terminals 162. Meanwhile, wires 8 are received in and protected by grooves 135 of shear blade presser 134.

(9) Thereafter, ram 106 is elevated and shear blade 131 restores the ordinary raised level with the aid of the springs 133. By the cylinder 122, unit 85 is bodily moved away from wire holder 83 back to the position shown in FIG. 29-A.

While the distance travelled by terminal attaching unit 85 is QQ_1, the amount of movement of the feed pawl 148 of conveyor device 137 is limited to Q_2Q_3 by the adjuster pieces 157 and 158. Hence a number of terminals 162 corresponding to the difference in distance QQ_1–Q_2Q_3 (four in the illustrated case) will be supplied in the next pressing step. In other words, a desired number of terminals can be fed to lower die 126 merely by adjusting the spacing between pieces 157 and 158.

The steps (1)–(9) discussed hereinabove will be repeated in sequence. Thus, a plurality of wire end portions can be subjected simultaneously to each step of removing the insulative covering cutting the conductive portion and fixing terminals onto the exposed end portions. It will readily occur to those who are skilled in the art that such procedures can take place automatically under known sequence control or can be controlled manually for each step. Terminal housing 11 can be attached to the thus obtained wire harness C to accommodate the terminal members and form completed wire harness D.

It will therefore be appreciated that a wire harness obtainable by the present invention promotes easy connection of terminal members and attachment of connectors and the like. Thus, as a whole, productivity is improved.

Although the present invention has been described in some detail by way of illustration and example for purposes of clarity of understanding, it will, of course, be understood that various changes and modifications may be made in the form, details, and arrangements of the parts without departing from the scope of the invention as set forth in the following claims.

What is claimed is:

1. A wire-laying head adapted to travel over a worktable for use in the manufacture of a wire harness comprising: a frame; wiring jig mount rotatably mounted on said frame; a plurality of equally spaced wiring jigs

located on top of said of jig mount; a clamping jig movably mounted on the bottom side of said frame for contacting a wire; guide pipes disposed on said wiring jig mount for guiding wires inserted through said wiring jig; and means selectively connectable to said wiring jigs for lowering and raising said wiring jigs at a predetermined position.

2. A wire-laying head according to claim 1, wherein said clamping jig is mounted for vertical movement relative to said jig mount and circular movement about the selected wiring jig positioned at said predetermined position, and said clamping jig having a cutting edge for cutting the wire.

3. A wire-laying head according to claim 1, including a plurality of guide rollers about the periphery of said wiring jig mount for rotatably supporting said wiring jig mount to said frame.

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